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Description and Operating Manual

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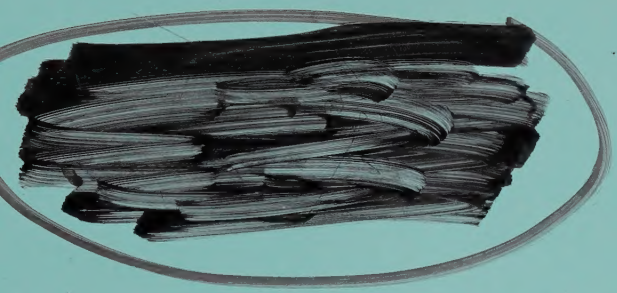

Level Measuring Set

PSM-5

for gain and attenuation measurements in the frequency range 10 kHz to 36 MHz

QUALITY ASSURANCE
STANDARDS, CALIBRATION, AND
MAINTENANCE LAB.

LEVEL MEASURING SET PSM-5

Frequency range 10 kHz to 36 MHz

Description and Operating Manual
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1 SPECIFICATIONS

1.1 Level Measuring Set PSM-5

BN 444 (dB calibration) BN 444/1 (Np calibration)

These specifications are valid for the permissible mains voltage fluctuations, an ambient temperature of 20°C and a warming-up time of at least 30 minutes.

1.1.1 Control Oscillator RWO-5 / BN 241

This unit serves for the common tuning of generator and receiver. It comprises the power supply for the complete instrument.

1.1.1.1 Frequency

Frequency range . . . . . 10 kHz to 36 MHz

Coarse frequency adjustment within the above range

locked mode . . . . spaced at 100 kHz intervals

free . . . . . continuous

Frequency adjustment of interpolation oscillator

switchable, coarse . . . -0.1 MHz to + 1 MHz with 2 kHz scale divisions and 10 kHz spacing of frequency check

fine . . . . -10 kHz to +100 kHz with 200 Hz scale divisions and 1 kHz spacing of frequency check

Frequency accuracy [1]

for integral 1 kHz values . . . . . $\beta \pm 10$ Hz

for optional frequency . . . . . $\beta \pm 100$ Hz

Internal standard frequency . . . . . 1 MHz

Accuracy on delivery after 1 hour warming-up time . . . . . $\pm 1 \cdot 10^{-6}$ or better

Aging rate per week . . . . . $\pm 0.05 \cdot 10^{-6}$

Mean temperature dependence . . . . . $\pm 0.2 \cdot 10^{-6}$/°C or less

No-load, peak-to-peak output voltage, square wave . . . . . approx. 2 V

Output impedance . . . . . 75 Ω

---

1) Insert the uncertainty of the standard frequency used in place of β. The values stated are valid for the range -10 kHz to +100 kHz of the interpolation oscillator. The values β ± 100 Hz or β ± 1 kHz apply to the range -0.1 MHz to + 1 MHz.

1 MHz external standard frequency input

Peak-to-peak voltage required . . . . . approx. 2 V in 500 Ω

Internal standard frequency is switched off as soon as d.c. resistance of max. 100 kΩ is in parallel to external standard frequency input.

1.1.1.2 Sweep Frequency Unit

19 sweep deviation ranges . . . . 35 Hz, 70 Hz, 140 Hz to 14 MHz, 35 MHz

Accuracy of selected frequency deviation ($f_{max} - f_{min}$) . . . . . ± 15 % or better

Accuracy of selected centre frequency

Deviation range 35 Hz to 35 kHz . . . . . better than ± 3 % of sweep deviation range

Deviation range 70 kHz to 1.4 MHz . . . . . better than ± 3 % of sweep deviation range ± 70 kHz

Deviation range 3.5 MHz to 35 MHz . . . . . better than ± 3 % of sweep deviation range ± 500 kHz

10 Sweep-frequency ranges [2] . . . . . manual, 0.1 Hz, 0.2 Hz, 0.5 Hz to 20 Hz, 50 Hz

Input for external sawtooth voltages . . . . . socket Bu 1601/5

Peak voltage required for sweep deviation . . . . . ± 3.5 V

Input impedance . . . . . 10 kΩ

Sawtooth voltage output . . . . . jack Bu 1601/1

No-load peak voltage . . . . . ± 3.5 V

Output impedance . . . . . 1 kΩ

Supply voltages

Mains (45 to 65 Hz)

Power consumption . . . . . 170 W

Switchable voltage ranges . . . . . 99 to 121 / 108 to 132 V
198 to 242 / 216 to 264 V

---

2) In position "50 Hz" the frequency range can be extended by inserting a capacitor between ground and socket Bu 1601/4 for any frequency below 50 Hz.

Battery operation

Power consumption . . . . . approx. 115 W

Voltage . . . . . 23 to 30 V

Permissible operating ambient temperature range . . . . . 0 to 40° C

1.1.2 Generator PS - 5

BN 242 (dB calibration) BN 242/1 (Np calibration, compare data in parenthesis)

1.1.2.1 Output Level

switchable to voltage level (0 dBm = 0 Np ≙ 0.775 V) or power level for all output impedance values (0 dBm = 0 Npm ≙ 1 mW in characteristic impedance).

Output I :

Max. output level (matched $R_L = R_i$) . . . . . + 2 dB/+ 12 dBm (+ 0.2 Np/+ 1.2 Npm)

however 135 and 150 Ω power level . . . . . + 10 dBm (+ 1 Npm)

Max. output voltage (matched $R_L = R_i$) . . . . . 1 V

Min. output level (matched $R_L = R_i$) . . . . . -85 dB/-75 dBm (-9 Np/-8 Npm)

Min. output voltage (matched $R_L = R_i$) . . . . . 50 µV

Adjustable in steps of . . . . . .10 dB (1 Np) or 1 V, 0.3 V, 0.1 V etc.

and continuously with 10-turn helical potentiometer

Output Impedance . . . . . 50, 60, 65, 75, 135 and 150 Ω

Output II : (loadable independently of output I)

Output level [3] . . . . . -15 dB to + 2 dB (-2 Np to + 0.2 Np)

Output voltage [3] . . . . . 0.1 to 1 V

continuously adjustable together with output I

Output Impedance . . . . . 75 Ω

Meter reading (3 scales)

Levels . . . . . -15 dB to + 2 dB (-2 Np to + 0.2 Np)

Voltages . . . . . 0.5 to 3 V and 1 to 10 V

Output voltage level accuracy of No. I output when matched ($R_L = R_i$)

For f.s.d. at f= 100 kHz in attenuator position 0 dB or + 10 dBm (0 Np or + 1 Npm). . . . max. ± 0.2 dB (± 0.02 Np)

---

3) The values apply to a load of R_L = 75 Ω in mode "voltage level", irrespective of the output attenuator setting of output I and corresponding with the output level meter reading.

Meter scale division accuracy referred to full scale value

for 50 to 75 Ω output impedance . . . . . ± 1.5 % or better
for 135 to 150 Ω output impedance . . . . . .+ 3 % or better

Attenuator accuracy for
f = 100 kHz, referred to
position 0 dB or + 10 dBm (0 Np or + 1 Npm) . . . . . ± 0.2 dB or better
(± 0.02 Np)

Frequency response of output level for constant
readings, referred to 100 kHz and 75 Ω matched

a) for reading 0 dB (0 Np) and

10 kHz to 15 MHz . . . . . within ± 0.1 dB (± 0.01 Np)
above 15 MHz to 36 MHz . . . . . within ± 0.3 dB (± 0.035 Np)

b) for reading -10 dB (-1 Np) and

10 kHz to 15 MHz . . . . . within ± 0.15 dB (± 0.015 Np)
above 15 MHz to 36 MHz . . . . . within ± 0.45 dB (± 0.05 Np)

c) for attenuator positions -10 dB to -70 dB (-1 Np to -7 Np) display 0 dB (0 Np) and

10 kHz to 15 MHz . . . . . within ± 0.2 dB (± 0.02 Np)
above 15 MHz to 36 MHz . . . . . within ± 0.5 dB (± 0.06 Np)

Reflection coefficient of Output Impedance (Output I and II)

for 75 Ω output impedance . . . . . .0.05 or less
for 50 to 65 Ω and 135 to 150 Ω output impedance . . . . . 0.1 or less

Harmonics Attenuation for 0 dB reading
2 nd or 3 rd harmonics and 75 Ω matched

10 kHz to 15 MHz . . . . . 40 dB (4.6 Np) or better
above 15 MHz to 36 MHz . . . . . 30 dB (3.5 Np) or better

Change of level reading depending on frequency and referred to a mean value
(level control unchanged) :

With a.g.c. operative (0 dB or 0 Np reading) . . . . . max. ± 0.1 dB
(± 0.01 Np)

with a.g.c. inoperative . . . . . ± 1 dB (± 0.1 Np)

1.1.2.2 External Amplitude Modulation . . . . . 0 to 100 %

Peak-to-peak voltage required in 600 Ω . . . . . 35 mV/% AM

Frequency range . . . . . 0 to 100 kHz

Frequency response referred to 1 kHz

for f_m = 0 to 30 kHz . . . . . within ± 0.1 dB (± 0.01 Np)
for f_m = 100 kHz . . . . . approx. – 0.1 dB (– 0.01 Np)

Overall distortion coefficient for
max. 30 % modulation, f_m = max. 20 kHz and
meter needle deflection of max. –5 dB (–0.5 Np) . . . . . 3 % or less

1.1.2.3 Effect of Operating Voltage Fluctuations

Mains or battery voltage fluctuations within the permissible range have no noticeable effect upon the output level

1.1.2.4 Permissible Ambient Temperature in Operation . . . . . 0 to 40° C

1.1.2.5 Effect of Ambient Temperature

Change of level reading of
min. –10 dB (– 1 Np) . . . . . + 0.05 dB/10°C (+ 0.005 Np/10°C)

Change of output level with
a g.c. operative . . . . . + 0.1 dB/10°C (+ 0.01 Np/10°C)

1.1.3 Receiver PM –5

BN 243 (dB calibration) BN 243/1 (Np calibration, compare data in parenthesis)

1.1.3.1 Level Readings

Switchable to voltage levels (0 dB = 0 Np ≙ 0.775 V) or power levels for all input impedances (0 dB = 0 Npm ≙ 1 mW in characteristic impedance)

Measuring ranges for meter reading 0 dB or 0 Np or f.s.d.

Voltage level, linear . . . . . –110 dB to +20 dB (–12 Np to + 2 Np)

Voltage . . . . . 3 µV to 10 V

Voltage level, logarithmic . . . . . –30 dB to +20 dB (–4 Np to +2 Np)

Power level, lin . . . . . –100 dBm to +30 dBm (–11 Npm to +3 Npm)

Power level, log . . . . . –20 dBm to +30 dBm (–3 Npm to +3 Npm)

Meter readings

Level, lin . . . . . –30 dB to +2 dB (–3 Np to +0.2 Np)

Level, log . . . . . –100 dB to +10 dB (–10 Np to 0 Np)

Voltage . . . . . 0.1 to 3 V and 0.2 to 10 V

Measuring accuracy at f = 100 kHz after calibration [4]

Mode "linear" for 0 dB (0 Np) meter reading

Voltage level	±0.25 dB (±0.025 Np) or better
Power level	±0.3 dB (±0.03 Np) or better
Scale dividing error for 0 dB (0 Np) meter reading	max. ± 1 % of full scale

Mode "logarithmic" for -20 dB (-2 Np) meter reading

Voltage level	±0.25 dB (±0.03 Np) or better
Power level	±0.3 dB (±0.03 Np) or better
Scale dividing error for -20 dB (-2 Np) meter reading	max. ±2 dB (±0.2 Np)

Frequency response of the reading for 100kHz and 75 Ω matched

10 kHz to 15 MHz	within ±0.2 dB (±0.02 Np)
above 15 MHz to 36 MHz	within ±0.6 dB (±0.06 Np)

1.1.3.2 Input

Input impedance switchable to 50, 60, 65, 75, 135, 150 Ω and $1/\omega C_{in}$

Input capacitance C_{in} in position $1/\omega C_{in}$ for frequencies up to 15 MHz	30 pF [5]

Reflection coefficient of input impedance

50, 60, 65, and 75 Ω	for 10 kHz to 15 MHz	0.02 or less
	above 15 MHz to 36 MHz	approx. 0.05
135 and 150 Ω	for 10 kHz to 15 MHz	0.1 or less

Max. permissible r.m.s. input voltage for 50 Ω to 150 Ω input impedances	10 V
Max. permissible d.c. voltage in position $1/\omega C_{in}$	250 V
Max. permissible peak a.c. voltage in position $1/\omega C_{in}$	15 V

1.1.3.3 Min. Harmonic Attenuation in "low distortion" mode, 2 nd and 3 rd harmonics [6]

for all attenuator positions and frequencies, when sensitivity is increased by 50 dB (6 Np) or in position "log." for max.-30 dB (-2 Np) meter reading of the fundamental wave (2 nd. or 3 rd. harmonics)	70 dB (8 Np)

---

4) The accuracies of the calibration oscillator and attenuators are combined. The attenuator accuracy is max. ± 0.15 dB (± 0.015 Np), the absolute measuring accuracy in position -20 dB (0 Np)(lin, low-noise) max. ± 0.1 dB (± 0.01 Np)

5) In the range 1 to 5 MHz, the loss factor may assume negative values. The absolute value of the effective parallel resistance is approx. 100 kΩ.

6) The guarantee does not refer to position +20 dB, (+2 Np) lin, for power levels, to all attenuator positions for the Z values 135 and 150 Ω. For these positions, the harmonics attenuation is approx. 70 dB (8 Np).

1.1.3.4. Selectivity

Passband range

Wideband Δa = 0.5 dB (0.06 Np)	Δf not less than ± 1 kHz
Δa = 3 dB (0.35 Np)	Δf not less than ± 1.6 kHz
	typical value Δf = ± 1.75 kHz
Effective noise bandwidth	2.7 kHz
Narrow band Δa = 0.5 dB (0.06 Np)	Δf not less than ± 0.1 kHz
Δa = 3 dB (0.35 Np)	Δf not less than ± 0.2 kHz
	typical value Δf = ± 0.25 kHz

Stopband range

Wideband Δa approx. 60 dB (6.9 Np) for	Δf = ± 4.0 kHz
Narrow band Δa at least 60 dB (6.9 Np) for	Δf = ± 2.0 kHz
Attenuation of intermediate frequency (69 MHz)	70 dB (8 Np) or better

Min. image rejection
(signal voltage output impedance 75 Ω) for:

Receive frequencies + 138 MHz	70 dB (8 Np)
Receive frequencies +14.88 MHz, +1.2 MHz, and +60 kHz	80 dB (9 Np)

1.1.3.5. Max. noise reading for 75 Ω input impedance and f = min. 80 kHz

Wideband	-121 dB (-13.5 Np)
Narrow band	-130 dB (-14.5 Np)

1.1.3.6. Outputs (floating, loadable up to short circuit)
Voltage for 0 dB (0 Np) meter reading in open-circuit operation

d.c. voltage Bu 1602/1, 10 kΩ impedance	4.6 (or 4.9) V
30 kHz output Bu 1602/2, 600 Ω impedance [7]	0 dB (0 Np)
Audio output Bu 1602/3, 5 kΩ impedance SSB in normal or inverted position	approx. 400 mV
Demodulation signal for 30 % mod., f = 1 kHz	120 mV
Socket for Scale Expander Bu 1603	4.6 (or 4.9) V
Socket for display plug-in Bu 1601	4.6 (or 4.9) V

---

7) The noise voltage without input signal is, in the attenuator position -110 dB (-12 Np) approx. -11 dB (-1.5 Np) for wideband and approx. -20 dB (-2.5 Np) for narrow band, in the mode "low noise", it decreases by 10 dB (1 Np) in each attenuator. However, it will not fall below -60 dB (-6.9 Np). For a linearity in accuracy of 1 %, the drive limit is about + 5 dB (+ 0.6 Np).

1.1.3.7 Permissible ambient temperature in operation . . . . . 0 to 40° C

1.1.3.8 Temperature dependence

Change of reading during the first two hours after switch-on without recalibration . . . . . max. ± 0.5 dB/h (± 0.06 Np/h)

Effect of ambient temperature upon reading without recalibration when input voltage is constant . . 0.1 dB/°C (0.01 Np/°C)

Effect of ambient temperature upon calibration level . . . max. 0.05 dB/10°C (0.005 Np/10°C)

1.1.3.9 Effect of operating voltage fluctuation

Mains or battery voltage fluctuations within the permissible range have no noticeable effect upon the level readings

1.2 Scale Expander AZD - 1

BN 364 (dB calibration) BN 364/1 (Np calibration, compare data in parenthesis)

The following values are valid 15 min. after switch-on and for an ambient temperature of 20° C.

Meter Scale range . . . . . -1 dB to +1 dB (-0.1 Np to +0.1 Np)

Scale division [8], scale markers of . . . . . .0.02 dB and 0.1 dB (0.002 Np and 0.01 Np)

Measuring range of scale expander (Level meter reading) . . . . . -10 dB to +2 dB (-1.0 Np to +0.2 Np)

Scale division error . . . . . ±4 % of reading ±0.01 dB (±0.001 Np)

Reading accuracy [9] when the instrument meter in its scale range -10 dB to +2 dB (-1 Np to 0.2 Np) is fully substituted by the scale expander. . . . ± 0.25 dB (± 0.025 Np) or better

Input voltage required for the scale expansion unit for dB (0 Np) reading on the feeding Level Meter . . . . . +4.6 (+4.9) V

---

8) For series A and B
Scale markers of 0.05 dB and 0.1 dB (0.005 Np and 0.01 Np).

9) This value is comparable with the scale-dividing error of the level meter. The value stated is valid if the linearity error of the level meter rectifier circuit at -10 dB (-1 Np) is max. 0.8 % of the full-scale value. Since a linearity error of -0.4 % was incorporated into the divider of the scale expander, the error is reduced by 0.1 dB (0.01 Np) if the linearity error of the level meter is likewise -4 % for a reading of -10 dB (-1 Np).

Interfering current across input . . . . . 300 nA

Differential input impedance . . . . . 30 MΩ

Operating voltage . . . . . + 18 V

Operating current . . . . . 10 mA

1.3 Probe TK - 8 / BN 363

The ratings below apply to 20° C ambient temperature and in connection with Level Meter PM-5 / BN 243 unless otherwise stated. The input of PM-5 is operated with the Probe in position $R_{in} = 1/\omega C_{in}$

1.3.1 Frequency range . . . . . 10 kHz to 36 MHz

1.3.2 Input level

Max. measuring range . . . . . + 2 dB (0.2 Np)

Max. peak input voltage U_s . . . . . 7 V

Attenuation adjustable . . . . . 2 dB (0.2 Np)

Max. d.c. voltage . . . . . 50 V

1.3.3 Frequency response of the reading, referred to 100 kHz

from 10 kHz to 15 MHz . . . . . within 0.3 dB (0.035 Np)

above 15 MHz to 36 MHz . . . . . within 0.6 dB (0.07 Np)

1.3.4 Input capacitance . . . . . 7 pF

1.3.5 Input impedance . . . . . 10 kΩ

1.3.6 Harmonics attenuation

Input level 0 dB (or 0 Np) second harmonic . . . . . approx. 50 dB (5.7 Np)
third harmonic . . . . . approx. 60 dB (6.9 Np)

Input level -20 dB (or -2.3 Np) second harmonic . . . . approx. 70 dB (8 Np)
third harmonic . . . . approx. 70 dB (8 Np)

1.3.7 Intrinsic noise

Probe terminated with 75 Ω

with the probe, the noise voltage
at 30 kHz is increased by . . . . . 6 dB (0.7 Np)
at 1 MHz or above . . . . . 3 dB (0.35 Np)

1.3.8 Permissible ambient temperature in operation . . . . . 0 to + 40°C

1.3.9 Max. change in attenuation with ambient temperature . . . . . 0.05 dB/10°C

1.4 Return Loss Measuring Accessory RFZ-5/BN 394

1.4.1 Impedance Values . . . . . Z = 50, 60, 65, 75, 135 and 150 Ω

1.4.2 Frequency Range

for impedance values of 50, 60, 65 and 75 Ω . . . . . 10 kHz to 36 MHz
135 and 150 Ω . . . . . 10 kHz to 5 MHz

1.4.3 Max. error [1] of measured reflection coefficient after calibration with the corresponding standard resistors (r = 0) and return loss standards (r = 0.1)

1.4.3.1 At fixed frequency

for impedance values of 50, 60, 65, 75 Ω and frequencies of

10 kHz to 5 MHz . . . . . ± k ± 0.01 r ± 0.0015
above 5 MHz to 15 MHz . . . . . ± k ± 0.03 r ± 0.003
above 15 MHz to 36 MHz . . . . . ± k ± 0.05 r ± 0.005

for impedance values of 135 and 150 Ω and frequencies of

10 kHz to 0.5 MHz . . . . . ± k ± 0.01 r ± 0.0015
above 0.5 MHz to 1.5 MHz . . . . . ± k ± 0.03 r ± 0.003
above 1.5 MHz to 5 MHz . . . . . ± k ± 0.05 r ± 0.005

1.4.3.2 In Sweep Mode [2]

for impedance values of 50, 60, 65, 75 Ω and frequencies of

60 kHz to 5 MHz . . . . . ± k ± 0.03 r ± 0.0015
60 kHz to 15 MHz . . . . . ± k ± 0.08 r ± 0.005
60 kHz to 36 MHz . . . . . ± k ± 0.10 r ± 0.015

at frequency of 10 kHz . . . . . approx. -0.2 r additionally

---

[1] The value of k is a function of the selected impedance value (Z) as can be seen from the following table

Z	50 Ω	60 Ω	65 Ω	75 Ω	135 Ω	150 Ω
k	0.05 r^2	0.03 r^2	0.02 r^2	0	0.07 r^2	0.09 r^2

Note that k is zero at an impedance value of 75 Ω independent of the measured reflexion coefficient and it can be ignored for lesser values of r at other impedance values. Apart from the errors stated, an additional percentage error in the indicated result occurs depending on the individual Level Meter employed : this error is defined as the sum of the inaccuracies introduced by the range selector switch and the meter scale division.

[2] In the sweep mode, an additional percentage error of the result indicated occurs in 75 Ω operation due to the frequency response of the individual Sweep Measuring Setup used. This additional error is not included in these specifications for RFZ-5.
Due to the fact that this additional error can partly be compensated for by the trimmer included in the RFZ-5 in the frequency range above 15 MHz, it can generally be ignored.

for impedance values of 135 and 150 Ω and frequencies of

60 kHz to 0.5 MHz	± k ± 0.03 r ± 0.0015
60 kHz to 1.5 MHz	± k ± 0.05 r ± 0.005
60 kHz to 5 MHz	± k ± 0.08 r ± 0.015
at frequency of 10 kHz	approx. –0.2 r additionally

1.4.4 Input and Output Impedance of Bridge . . . . . 75 Ω

1.4.5 Required generator output impedance or receiver input impedance. . . . . 75 Ω

1.4.6 Attenuation of Bridge at r = 1 . . . . . 47 dB

1.4.7 Test object level at r = 0 . . . . . 23 dB below input level

1.4.8 Dimensions (in mm) . . . . . width 140 height 40 depth 90

Weight . . . . . 310 g

1.4.9 Accessories

1.4.9.1 Standard (connections 2.5/6 mm)

1 Carrying Case

2 Cables Z = 75 Ω (generator or receiver cable)

1 Standard Resistor R_N, 75 Ω plug

1 Standard Resistor R_N, 75 Ω socket

2 Signal Leads, length 25 cm, Z = 75 Ω

1 Calibration Resistor R_E, 75 Ω socket

1.4.9.2 Optional

50, 60, 65, 75, 135 and 150 Ω type

2 adapters each (generator or receiver cable) for 4/13 and BNC

1 adapter each for R_x with 4/13 plug, 4/13 socket, BNC plug and socket

2. INTRODUCTION

The ever increasing demands for improved accuracy of instruments applied to level and attenuation measurements of four pole networks has led to the design of the Level Measuring Set PSM-5. Its development was governed by the requirements for an instrument with a wide and easy operation.

The Level Measuring Set PSM-5 permits all customary level and attenuation measurements of active and passive four-pole networks in the frequency range 10 kHz to 36 MHz. When used in conjunction with the Display unit SG-1 and its associated Plug-in Unit SGE-10, the Sweep Measuring Set WM-50 is formed. It is thus possible to measure test object frequency response characteristics automatically and to display these characteristics on the CRT screen of the Display Unit SG-1.

The measuring set is suitable both for objects possessing very wide-band frequencies (up to 36 MHz) and for extremely narrow-band objects such as crystal filters. Its high frequency stability and accuracy is achieved by frequency locking and by reference to an internal crystal standard. The highly sensitive selective receiver can be tuned in common with the generator so that selective measurements are just as easy to carry out as wideband measurements.

When operating in the narrow band, low noise mode, and with an input signal level of at least -60 dB (-7 Np), the measuring set can also be used for a number of measurements (e.g. frequency response) at frequencies below 10 kHz (down to 2 kHz).

The generator can be amplitude-modulated up to 100 % with frequencies from d.c. to 100 kHz.

3. DESIGN AND THEORY OF OPERATION

3.1. Design of the Measuring Set

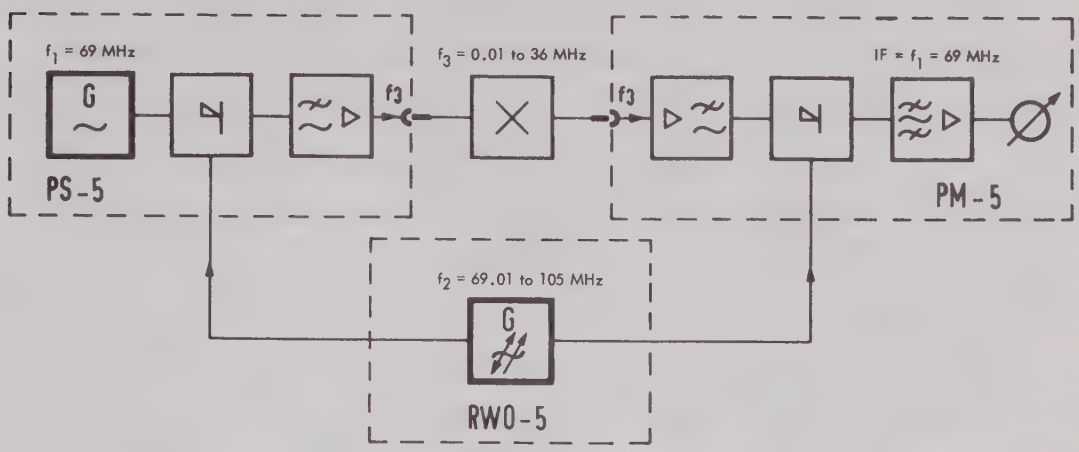


Fig. 1 Block diagram of the Level Measuring Set PSM-5

For most measuring problems it is necessary to tune the generator and the receiver of a measuring set to the same frequency. It is of advantage to arrange these units so that the synchronous tuning can be accomplished with the aid of a control oscillator. This is feasible when the fixed frequency f_1 of the generator and the first intermediate frequency IF_1 of the receiver are identical. On using the same control frequency the generator output frequency will be identical to the receive frequency of the receiver.

Since these requirements were taken into consideration when these units were developed, the Level Measuring Set PSM-5 is made up of a Signal Generator PS-5, a Level Meter PM-5, and only one Control Oscillator RWO-5. This results in a clear configuration of the measuring set and facilitates operation. As before, it is possible to combine one generator or one receiver with an oscillator unit. The most economical solution, however, is generally provided by the PSM-5 arrangement.

In the following, the functions and the significant features of the instrument are described. The description applies not only to the complete instrument PSM-5, but also to the generator itself as an individual unit, PSO-5 and the receiver as an individual unit, PMO-5.

3.2. The Control Oscillator RWO - 5

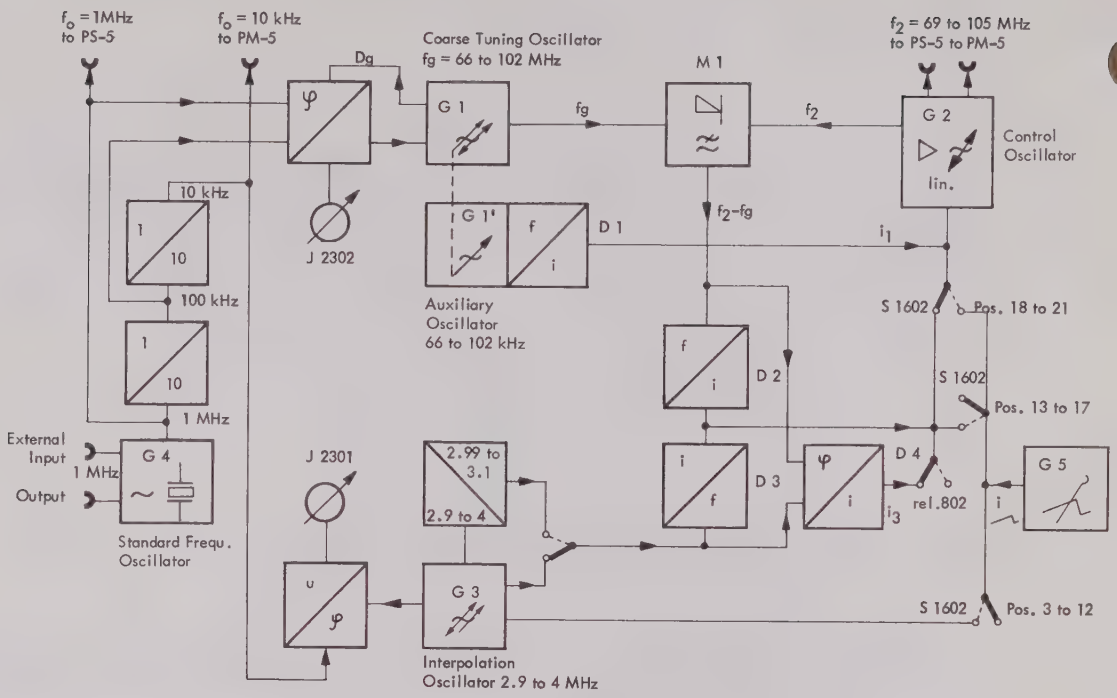


Fig. 2 Block diagram of Control Oscillator RWO-5

In the Control Oscillator RWO-5, two oscillators are used to adjust the control frequency for generator and receiver. The control frequency f_2 is generated in the oscillator G_2 which can be tuned electronically without range switching over the full frequency range from 69.01 to 105 MHz. A linearizing circuit ensures linear correlation between control current and control frequency. f_2 is applied to the control signal output sockets for generator and receiver and to the mixer M_1 to which the frequency f_g of the coarse tuning oscillator is also fed. The frequencies f_2 and f_g must differ by about 3.0 MHz. To achieve this, f_2 must be adjusted by a control current proportional to f_g to a value approx. 3.0 MHz higher than f_g. Since a frequency discriminator for the original frequency f_g is difficult to attain, the auxiliary oscillator G_1' is tuned synchronous to G_1. The frequency of G_1' is lower than f_g by the factor 1000. The frequency discriminator D_1 connected to G_1' determines the basic tuning of G_2 by means of its current i_1.

The difference of the frequencies f_2 and f_g is filtered-out at mixer M_1 via a low-pass filter network (LPFL). A proportional direct current is derived from the frequency

discriminator D_2. The frequency of the interpolation oscillator f_i is likewise converted into a proportional direct current in the frequency discriminator D_3. D_2 and D_3 have identical frequency/current characteristics. Their output currents, however, are of opposite polarities. Thus for the condition $f_2 - f_a = f_i$, the sum current i_2 of the discriminators becomes zero. If the frequencies have different values, i_2 is superimposed as a correction current to the current i_1 and G_2 is retuned until $f_2 - f_g$ and f_i differ only by the control error of the discriminators D_2 and D_3.

The remaining frequency difference between $f_2 - f_g$ and f_i is so small that it falls into the pull-in range of the phase discriminator D_4. The discriminator can thus supply a correction current i_3 that is likewise superimposed on i_1. G_2 is retuned by this current until $f_2 - f_g$ and f_i exactly coincide.

The accuracy of f_2 thus depends only on the accuracy of the coarse-tuning and interpolation oscillator frequencies.

3.2.1. Manual Tuning

The coarse-tuning oscillator can be used to adjust the control frequency over the whole range. The tuning can be continuously or in steps via the frequency locking markers of a crystal spectrum.

In continuous tuning, the set has the accuracy of a good LC generator. In the locked mode the frequency jumps always to the next harmonic of a 100 kHz crystal spectrum during tuning of the coarse tuning oscillator. Locking is accomplished automatically by a phase discriminator D_g during oscillator tuning. Thus in the locked mode, the coarse tuning oscillator has the accuracy of the built-in standard-frequency crystal oscillator G 4. The 1 MHz frequency of G 4 is used to derive the 100 kHz locking frequency spectrum by frequency division.

The meter J 2302 indicates locking of the oscillator. The locking of the oscillator to a multiple of 1 MHz can be clearly distinguished from the positions forming multiples of 100 kHz by a special mark on the meter scale.

In the 360 frequency sub-ranges obtained by locking the coarse-tuning oscillator, continuous tuning is possible with the interpolation oscillator. The oscillator permits, in x 1 position, the adjustment of intermediate values from -10 kHz to +100 kHz.

Its frequency scale can be checked at all multiples of 1 kHz with the aid of J 2301 and can be recalibrated if necessary. The frequency checking permits an adjustment

accuracy at the check points that is better than ± 10 Hz. Between the check points, a reading and scale-division error is introduced.

If use of the continuous frequency tuning in manual testing of the object over several 100 kHz is desired, the adjustment range of the interpolation oscillator can be multiplied by the factor 10. Thus, frequency ranges of 1.1 MHz width can be covered without readjusting the main tuning oscillator. The spacing between the check points in this case is 10 kHz, the adjustment accuracy at the check points is better than ± 100 Hz.

If the accuracy of the built-in standard-frequency oscillator of $\pm 2 \cdot 10^{-6}$ at 20° C is insufficient for certain measurements, the oscillator can be substituted by an external 1 MHz frequency standard.

The tuning elements of the coarse-tuning oscillator and the interpolation oscillator are variable capacitors driven with the aid of a flywheel for convenient operation. The scale is individually calibrated for each oscillator. The scale divisions are photographically applied to a glass disc, directly mounted on the variable-capacitor shaft. This ensures a high accuracy and stability of the scale divisions. The scale disc is subject to no wear. The scale divisions are magnified and projected onto a ground-glass pane by an optical lens system, thus ensuring a parallax-free read-out. The projected scale length is 2.5 meters (in excess of 8 ft).

3.2.2 Sweep - Frequency Operation

Included in the instrument are all devices for sweeping the control frequency electronically and is thus noiseless and subject to no wear. The sweep deviation and the sweep frequency are variable in wide limits and can be adapted to any object under test. The RWO-5 is swept with a sawtooth signal generated in the sawtooth oscillator G 5. The sweep deviation of ± 17.5 Hz can be varied in 19 steps up to ± 17.5 MHz by a variation of the sawtooth current amplitude and feeding to control circuit points having different sensitivities. The interpolation oscillator is swept to generate the small sweep deviations between ±17.5 Hz and ± 17.5 kHz. The control current for G 2 remains fully effective.

For sweep deviations between ±35 kHz and ±700 kHz, the phase discriminator D_4 is disconnected by relay rel 802 and the sawtooth signal current is superimposed on the currents i_1 and i_2. For the large sweep deviations between 1.75 MHz and ± 17.5 MHz

the frequency discriminators D_2 and D_3 are disconnected and the sawtooth current is superimposed on the current i_1 only. From this it may be seen that, for sweep deviations of ± 1.75 MHz or greater, the centre frequency is adjusted only on the coarse tuning oscillator; for all smaller deviations, the centre frequency is adjusted only by the interpolation oscillator. Since the coarse tuning oscillator can be frequency locked for these ranges, a good stability of the adjusted centre frequency in this range can be expected.

The sweep frequency is variable between 50 Hz and 0.1 Hz. It can be further decreased by including capacitors at a socket provided for this purpose. The sweep voltage can also be varied manually or substituted externally.

The sweep voltage of the sawtooth generator is available at a socket for connection of a display unit. A signal indicating the retrace of the sawtooth can also be derived from this socket.

3.3. Generator PS-5

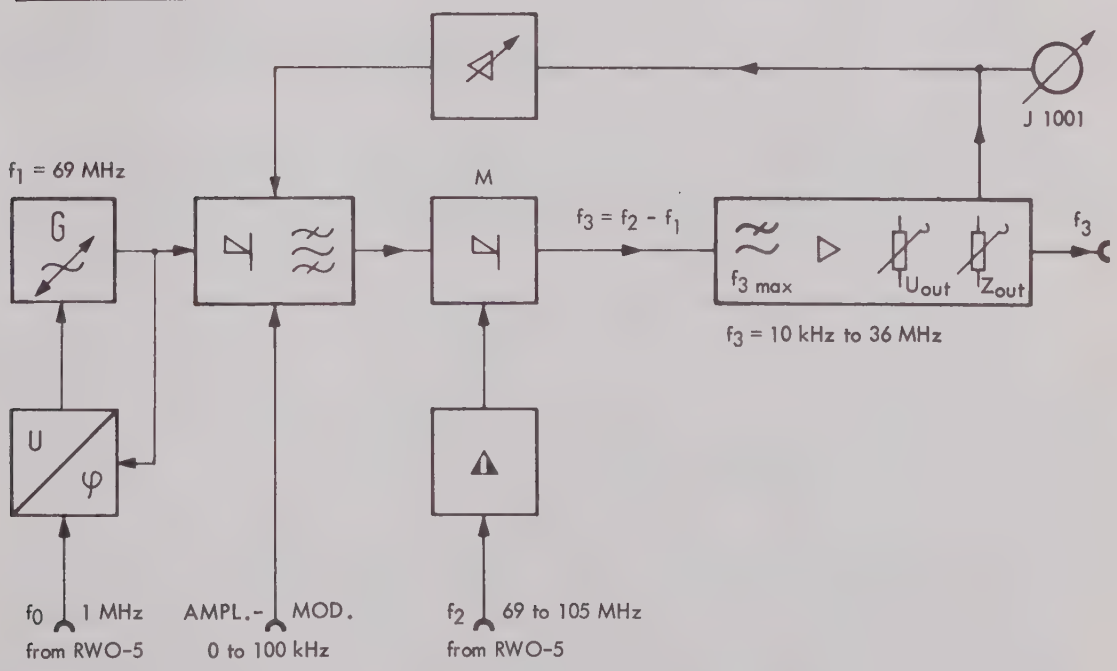


Fig. 3 Block Diagram of the Generator PS-5

The PS-5 operates on the beat-frequency principle. Its output frequency f_3 is the difference from the control frequency f_2 of the RWO-5 and the fixed frequency f_1 of 69 MHz. Thus f_1 is locked by means of a phase discriminator to the 69th harmonic of

the standard frequency oscillator in the RWO-5

The output frequency f_1 of the 69 MHz oscillator is applied to the mixer M via an amplitude modulator and a 69 MHz bandpass filter for rejection of the 69 MHz harmonics. The difference $f_2 - f_1$ is filtered out of the mixer output in the following LPFL. The mixer is square-wave keyed by the control frequency f_2 via an amplifier and limiter so that the conversion transconductance is virtually independent of the amplitude and frequency f_2 of the control voltage.

The voltage of the difference frequency f_3 appearing at the LPFL output is amplified and applied to the generator output via a calibration circuit and an output impedance selector. The output voltage is rectified and indicated by the meter. Thus the signal level across the output terminals is indicated in accordance with the position of the output attenuator.

When the PS-5 is used as a sweep-frequency generator, the frequency response of the output level should be as flat as possible. To this end, the d.c. voltage obtained from the output signal is amplified and compared with a standard voltage in a differential amplifier. The output voltage of the differential amplifier is applied to the amplitude modulator functioning as a final control element in this a.g.c. circuit to correct the output level.

To adjust the output level, the standard voltage is varied. Since this is a d.c. voltage, a 10-turn potentiometer can be used which ensures good adjustment of the output level.

The generator can be amplitude-modulated up to 100 % via the modulation input with frequencies between 0 and 100 kHz. In this mode, the a.g.c. of the output level is out of circuit.

3.3.1. Voltage and Power Levels

The generator and receiver can be easily switched from voltage-level calibration (0 dB = 0 Np $\hat{=}$ 0.775 V) to power-level calibration (0 dBm = 0 Npm $\hat{=}$ 1 mW into Z). The level scale of the generator meter as well as the two level scales of the receiver meter are applicable in both modes of operation. This is accomplished by a mechanical shift of the measuring-range indication by 10 dB or 1 Np and by an electrical correction of the meter needle deflections or instrument gain depending on the selected impedance value. This ensures simple and correct level readings.

3.4 Receiver PM-5

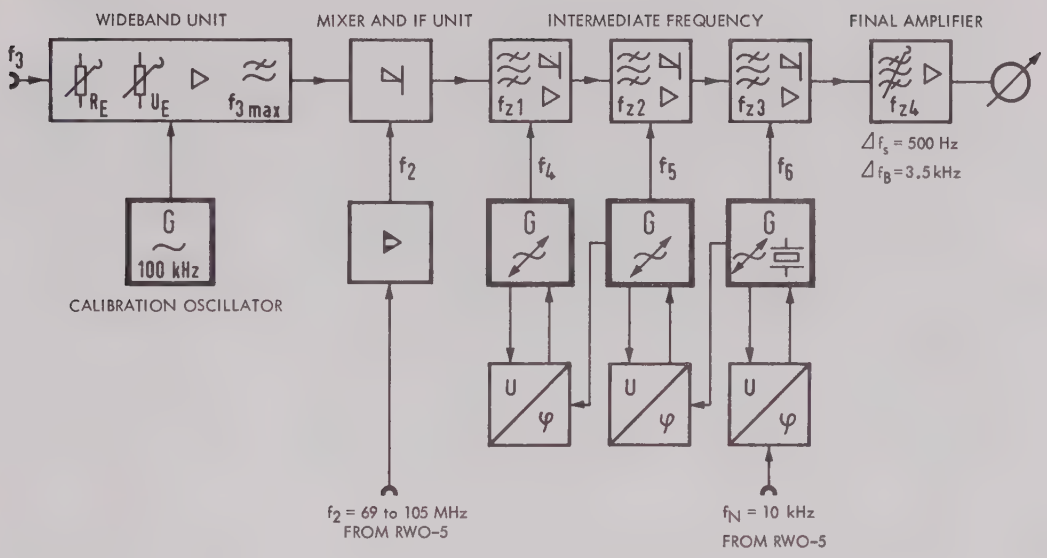


Fig. 4 Block Diagram 1 for PM-5 Receiver

The receiver operates on the heterodyne principle. The receive signal is fed via the wideband unit to the mixer and is converted with the control frequency f_2 to the fixed intermediate frequency IF_1.

3.4.1 Wideband Unit

The input impedance of the set can be switched to all customary characteristic-impedance values. Moreover, the input can be operated at high resistance. In the high impedance mode, the effective input resistance is virtually equal to $1/\omega C_{in}$. Here C_{in} is the input capacitance. It is constant over the whole sensitivity range. The input circuit comprises a buffer stage - the only valve stage of the whole measuring set - and the input attenuator serving to adjust the receive signal to the level of the set. The signal so prepared is amplified in a wideband amplifier and then applied to a low pass filter. The LPFL suppresses all frequencies above the receive band (image frequencies), thus ensuring the unambiguity of the frequency received.

From the LPFL, the signal of the frequency f_3 is fed to the mixer to which the control frequency f_2 is also fed via a limiting amplifier. The mixer is switched by f_2 so that its

conversion transconductance is in wide limits independent of the amplitude and the frequency f_2 of the control voltage.

3.4.2 Intermediate Frequency (IF)

From the frequencies generated in the mixer, the difference frequency $f_2 - f_3 = IF_1$ of 69 MHz is filtered out in a band pass filter (BPFL). Since it is not possible to attain the specified receiver selectivity with this frequency the 1st IF undergoes a triple conversion and is then mixed down into a frequency range in which the design of band pass filters with the desired selectivity is facilitated. This IF_4 is 30 kHz. In each conversion stage, the signal is amplified and the new IF is filtered out by a BPFL which rejects the image frequencies and other undesired mixer outputs. The bandwidth of the last BPFL (IF_4) is switchable between 500 Hz and 3.5 kHz. From this BPFL, the signal is fed to the final amplifier.

3.4.3 Local Oscillators

The frequencies of the local oscillators required for the conversion must meet the same stability requirements as the control frequency f_2 and the fixed frequency f_1 in the generator. Therefore, the oscillators must be locked to the standard frequency of the RWO-5. This problem was solved in the following way: The oscillator with the lowest carrier frequency f_6 is locked directly to a harmonic of the standard frequency with the aid of a phase discriminator. The frequencies f_5 and f_4 of the other two carrier oscillators are so chosen that f_5 is a harmonic of f_6 and f_4 is a harmonic of f_5. In this way, suitable phase discriminators can provide coincidence between f_5 and f_6 as well as between f_4 and f_5. Thus only one standard-frequency connection between RWO-5 and PM-5 is required.

3.4.4 Final Amplifier

In the final amplifier, the converted receive signal is amplified, rectified and indicated by the receive-level meter. The amplifier has an attenuator serving to adjust the input sensitivity of the equipment in connection with the input attenuator.

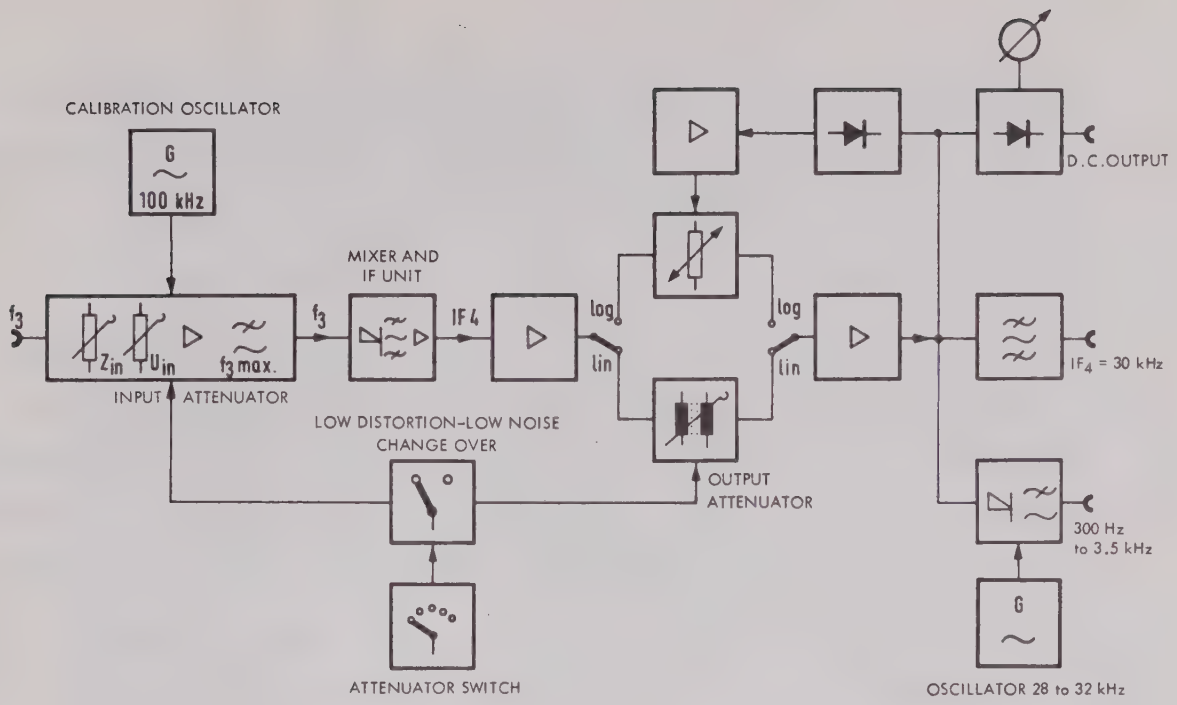


Fig. 5 Block Diagramm II for PM-5

In the linear signal display mode, an amplitude range of about 10 : 1 (20 dB) is covered by the meter and, in sweep operation, by the CRT screen of the display unit. In the case of many measurements when, for instance, the bandstop properties of filters are investigated or spectral analyses are made etc. much greater attenuation differences occur. For such measurements, the final amplifier can be switched to act as a logarithmic amplifier. Conversion into a logarithmic scale is accomplished with the aid of silicon diodes which are then connected into the amplifier channel. These diodes have a logarithmic current-voltage characteristic over a wide range. They represent the load impedance of a 30 kHz amplifier stage supplying the source current. Their change of impedance is effected by a d.c. voltage proportional to the output voltage and applied to the diodes via a g.c. amplifier. The characteristic of the set is thus logarithmic in a range of 100 dB (resp. 10 Np). For this purpose, the meter has an attenuation scale calibrated in 10 dB (resp. 1 Np) steps. This scale has divisions that correspond to the voltage scale for linear readings. It can easily be transferred to the display unit or a recorder.

3.4.5 Switching from Low-Distortion to Low-Noise Operation

The measuring problems for a selective receiver can be classified in two main groups. The first group would comprise analyses of frequency spectra, the other would cover attenuation and level measurements.

3.4.5.1 Low-Distortion Mode

The intrinsic distortion of the instrument under over-modulation conditions must be kept as small as possible for frequency analyses, especially during high distortion attenuation measurements and when the fundamental wave is not suppressed. This means that the receive signal across the input of the set should be small i.e. the input attenuator should reduce the signal to an extent as determined by the requirements of the final amplification of the set.

3.4.5.2 Low-Noise Mode

Normally the intrinsic distortion will not affect the result of level and attenuation measurements. For this type of measurements, especially when very small level differences are to be measured or sweep measurements are used, the interference in the set, added to the signal voltage, especially the noise, should be as low as possible. The receive level should, therefore, be as high as possible and attenuated only in the output attenuator.

These two modes, low-distortion or low-noise, are available in the PM-5 and can be push-button selected. In the most sensitive measuring range, they are identical. In all other sensitivity ranges, a change-over unit actuates that attenuator which corresponds to the mode. When beginning with the most sensitive position, the output attenuator is switched on first in the low-noise mode. In the low-distortion mode, the input attenuator is switched on first. The other attenuator in each case becomes operative only when the desired property of the set is no longer changed.

Mode change-over has no effect upon the instrument sensitivity selected by the divider switch.

3.4.6 Outputs, Demodulator

The PM-5 has several outputs for further processing of the converted receive signal. One output supplies the final intermediate frequency of 30 kHz. The output level is

indicated by the meter (output impedance = 600 Ω). A d.c. voltage proportional to the IF is available at three further outputs. Two of these multi-pole outputs are provided for connection of accessories (AZD-1 and SGE-10). These also supply the operating voltage for the scale expander and the control signals for these accessories. The third socket supplies the d.c. voltage for a recorder or similar equipment. The output voltage at f.s.d. is 6 volts (output impedance = 10 kΩ).

A further output is derived prior to demodulation. The instrument bandwidth in the wideband mode corresponds approximately to that of a voice frequency channel. Such a voice frequency channel in normal or inverted position can be reset into the original position by mixing with an oscillator frequency of 28 to 32 kHz.

This enables any channel of a carrier system to be converted into the audible range. In the narrow-band position, the bandwidth is approx. 500 Hz. This band can be converted to a centre frequency of 1 kHz.

Double-sideband signals can also be demodulated. The output permits connection of any conventional head-set.

Output loading has no effect upon the measuring accuracy of the instrument.

2.4.7. Mutual Impedance

The ground of the receiver portion is isolated from the chassis of the RWO-5 and PS-5. A finite mutual impedance is caused between the separate ground potentials of the power supply of the PM-5 from the RWO-5, the control frequency and the standard frequency connections and the mechanical assembly of the units.

This mutual impedance remains high in regard to the sheath of a co-axial cable throughout the whole measuring frequency range, thus ensuring that the whole return flow of the RF current is passed by the measuring cable from the test object to the generator portion. This ensures that no measuring result errors can be introduced by unwanted leakage current e.g. via the ground lead or the control cable connection between generator and receiver during measurements on test objects having high attenuation.

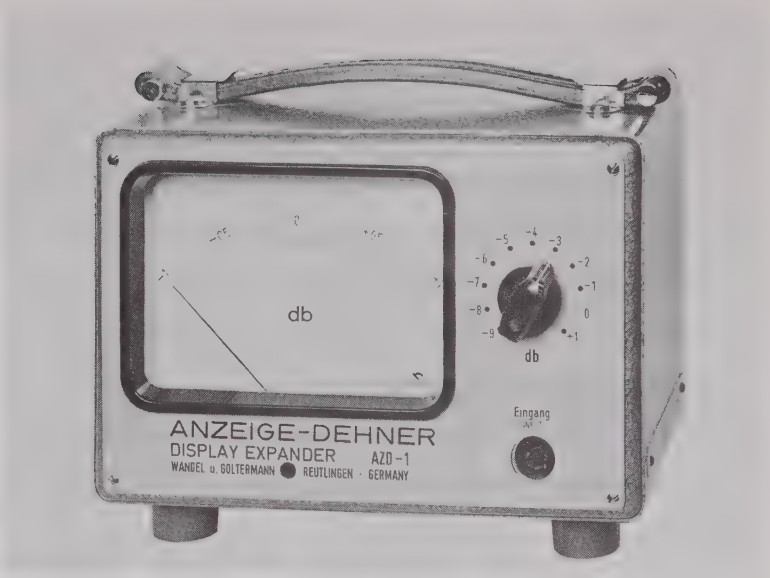


Fig. 6
Display Expander
AZD-1

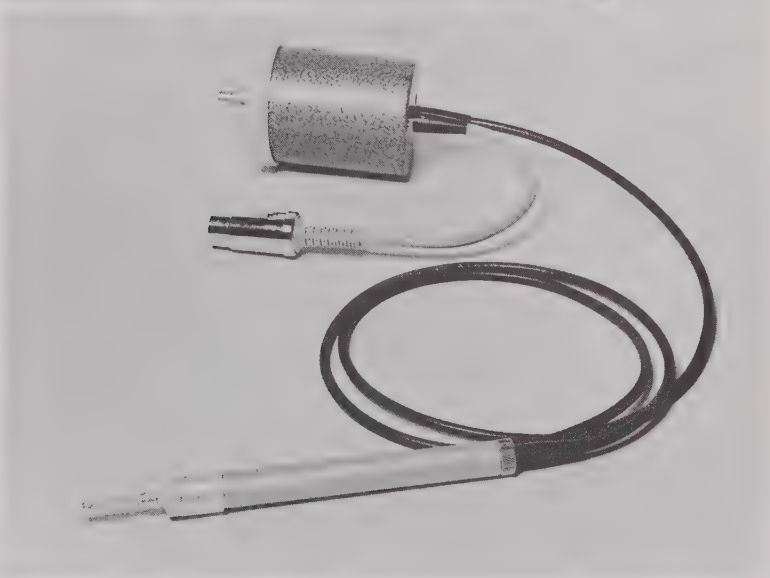


Fig. 7
Probe TK-8

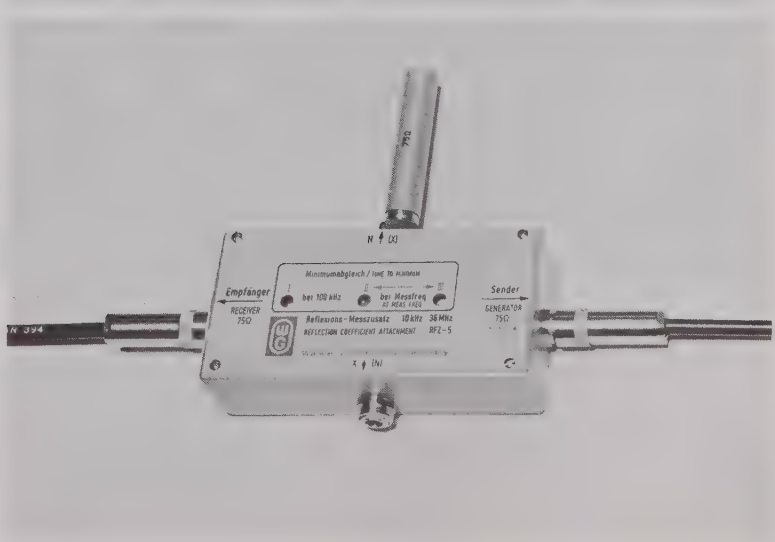


Fig. 8
Return Loss Accessory
RFZ-5

4 PSM - 5 ACCESSORIES

4.1 Scale Expander AZD-1

This unit serves to measure extremely small level differences. It has a scale range of ± 1 dB or ± 0.1 Np. Its selector switch with 11 steps of 1 dB or 0.1 Np each, overlaps the 10 dB or 1 Np steps of the PM-5 attenuation switch.
The reference line of the SGE-10 can also be transferred to the AZD-1.

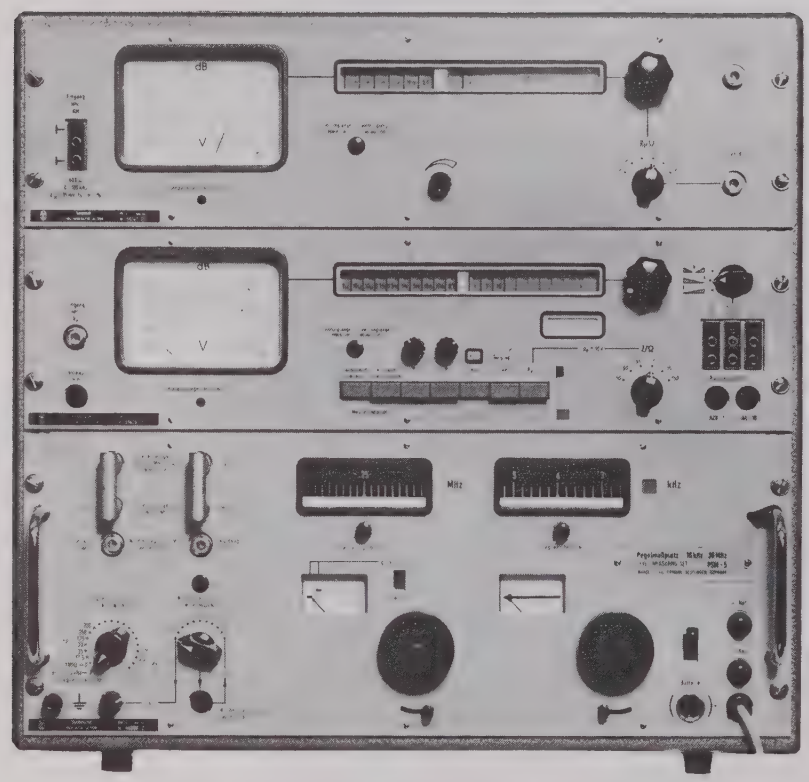
The operating voltage is obtained from the PM-5.

4.2 Probe TK-8

When the probe is connected, the input capacitance of the PM-5 is reduced to 7 pF. Its input impedance is 10 kΩ and its insertion loss is 2 dB. The probe permits signal derivation from points of difficult access without excessive loading of the object under test by a cable.
The operating voltage of the probe is obtained from the PM-5.

4.3 Return Loss Accessory RFZ-5

This unit serves to measure and sweep the return loss of objects referred to standards. The connecting leads to the PSM-5 are matched to 75 Ω. The accessory can thus be connected via lengthy cables and positioned close to the object under test.



LEVEL GENERATOR
PS-5/BN 242

LEVEL METER
PM-5/BN 243

CONTROL OSCILLATOR
RWO-5/BN 241

Fig. 6

5 OPERATING INSTRUCTIONS

5.1 Power Supply

5.1.1 Mains Operation

The instrument can either be operated in one of four mains voltage ranges at a mains frequency between 45 and 65 Hz or from a 23 to 30 V battery. Provision is made for switching the instrument mains transformer as follows :

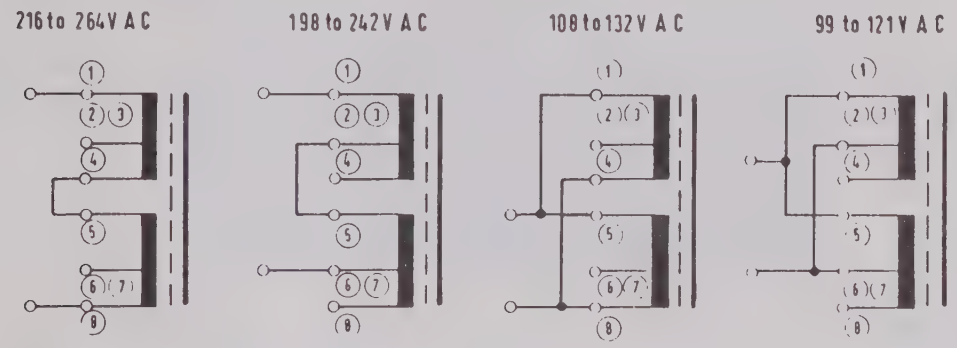


Fig. 7

The instrument is generally delivered adjusted for 198 to 242 V mains and fitted with a 1 amp. slow-blow fuse. Further mains voltage ranges can be provided for prior to delivery if desired.

5.1.2 Battery Operation

The battery is connected via a lead to socket Bu 2401. Simultaneous connections to both mains and battery, with the latter floating, is provided for by including a diode which protects the instrument against erroneous battery pole connection. Battery loading thus results only when the value of the rectified a.c. at the charging capacitor falls below the battery voltage. In the battery operating mode the current drain at min. battery voltage is approx. 5 A and 3 A at max. battery voltage.
The instrument ON/OFF switch is S 2401: when switched on, the projection scales of RWO-5 must light up.

5.1.3 Meter Zero

Prior to switching-on it is advisible to check and correct if necessary the meter zero of both J 1001 on the generator front panel and J 1901 on the receiver unit.

5.1.4 Warming-Up Time

The PSM-5 is ready for operation after approx. 30 s. which is the warm-up time of the receiver input valve. Measurements may then be undertaken with the instrument, the accuracy, however, is not that as stated in the specifications prior to an operating period of at least 30 min.

During initial operating time the coarse-tuning oscillator may drift from its locked frequency and hence slight retuning may be necessary.

5.2 Control Oscillator RWO-5 (see Fig. 8)

5.2.1 Frequency Adjustment

Both the generator and receiver frequency of the PSM-5 are simultaneously adjusted on the RWO-5 front panel. This ensures that the receiver and generator are tuned to a single, common frequency. This is achieved by setting the sweep width selector S 1602 to either "0 to 100 kHz" or "0 to 1 MHz". The generator output frequency or receiver input frequency is given by the sum of the frequency values indicated on the two RWO-5 frequency scales. Note that the frequency indication of the interpolation oscillator must be multiplied by a factor of 10 when selector S 1602 is in the position "0 to 1 MHz".

The frequency of the coarse tuning oscillator is adjusted by means of control D 1 and that of the interpolation oscillator with control D 2.

The controls are provided with flywheels and thus a single turn is sufficient to detune the oscillator in question over a considerable frequency range. Having adjusted approximately to the desired frequency, actuate the brake located under the control by positioning the brake peg to the right. Then adjust for accurate frequency. The brake prevents any undesirable shift of the control knob.

When tuning the oscillator over a wide range, adjust the brake peg to its left position.

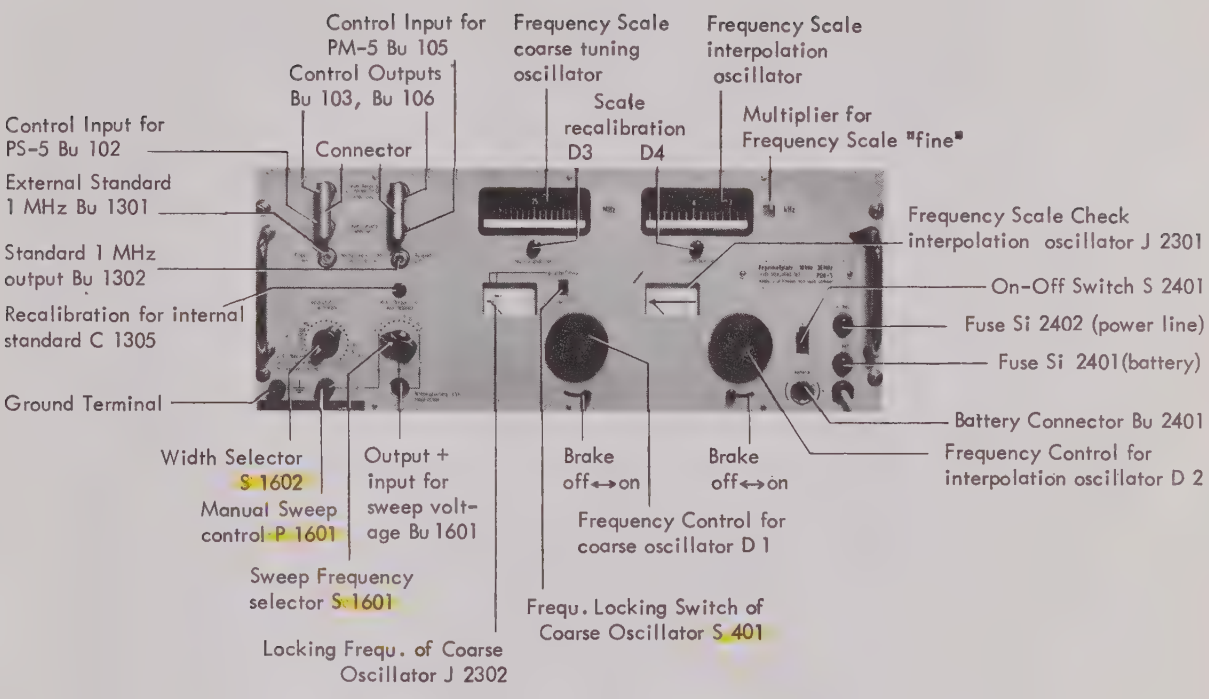

Control Input for PM-5 Bu 105
Control Outputs Bu 103, Bu 106
Frequency Scale coarse tuning oscillator
Frequency Scale interpolation oscillator
Scale recalibration D3 D4
Multiplier for Frequency Scale "fine"
Control Input for PS-5 Bu 102
Connector
External Standard 1 MHz Bu 1301
Frequency Scale Check interpolation oscillator J 2301
Standard 1 MHz output Bu 1302
On-Off Switch S 2401
Recalibration for internal standard C 1305
Fuse Si 2402 (power line)
Fuse Si 2401(battery)
Ground Terminal
Battery Connector Bu 2401
Frequency Control for interpolation oscillator D 2
Width Selector S 1602
Output + input for sweep voltage Bu 1601
Brake off↔on
Brake off↔on
Manual Sweep control P 1601
Frequency Control for coarse oscillator D 1
Sweep Frequency selector S 1601
Frequ. Locking Switch of Coarse Oscillator S 401
Locking Frequ. of Coarse Oscillator J 2302

Fig. 8 RWO - 5

5.2.2. Coarse Tuning Oscillator

This oscillator can be tuned continuously or frequency locked at multiples of 100 kHz. Adjust the switch S 401 to the desired mode. In the "free" position of selector S 401, the oscillator can be continuously tuned over the full frequency range. After calibration of the frequency scale, its frequency accuracy is about ± 20 kHz (see 5.2.2.2.). When selector S 401 is positioned to "locked", the oscillator can be locked to a 100 kHz crystal frequency spectrum. This is achieved automatically as soon as the oscillator frequency approaches the corresponding 100 kHz harmonic during tuning. The oscillator has then the accuracy of the built-in standard.

5.2.2.1. Locking Frequency Indication

Meter J 2302 serves to indicate the locking frequency. In this mode the meter needle points to one of the two left-hand frequency markers, either the 100 kHz marker (if the frequency adjusted is a multiple of 100 kHz) or the 1 MHz marker (if the frequency is also a multiple of 1 MHz). The centre of pull-in range is exactly adjusted when the needle has jumped to the locking marker and the control D 1 is no longer operated. Actuate the brake before adjusting the locked position. The frequency locking to a multiple of 500 kHz is additionally marked by a meter dip towards the 1 MHz field, which will be apparent at the centre of the pull-in range. The control knob should therefore be rotated slightly further in the same direction after locking in. This allows the scale divisions of 1 MHz, 500 kHz and 100 kHz multiples to be unambiguously differentiated from another. A dip could also be noticed between two adjacent 100 kHz locking points but confusion with an actual 100 kHz locking point is not possible. An unlocked condition will occur when the oscillator is tuned beyond the pull-in range of the locking circuit. The oscillator will free-run until the next locking point is reached. Operation of the oscillator in this state, however, should be avoided.

5.2.2.2. Calibration of the Frequency Scale

When locked, the frequency scale can be calibrated by tuning the control knob D 3 so that the calibration pointer is adjusted to the corresponding scale division. Since the centre of the pull-in range can be exactly determined at multiples of 500 kHz, it is advantageous to calibrate the frequency scale at a 500 kHz marker.

3. Interpolation Oscillator

This is a free-running LC oscillator with high frequency stability. Its frequency is

adjusted with the control D 2. When the sweep width selector S 1602 is adjusted to position "0 to 100 kHz", the oscillator has a detuning range from -10 kHz to +100 kHz so that the range between the individual locking points is covered when the coarse tuning oscillator is locked. This detuning range can be increased by a factor of 10 by positioning selector S 1602 to "0 to 1 MHz". In this position, the frequency-scale reading should be multiplied by 10. The detuning range - 100 kHz to + 1 MHz is marked by the luminuous symbol "x 10" to one side of the frequency scale.

5.3.2.1. Calibration of the Frequency Scale

The interpolation oscillator can be compared with multiples of 1 kHz (or 10 kHz in position "x 10") by means of the meter J 2301 located below the frequency scale. At minimum meter reading, the oscillator frequency coincides with the locked crystal frequency with an accuracy better than ± 10 Hz (or ± 100 Hz in position "x 10"). The calibration pointer is then adjusted to the next kHz marker with control D 4. When the scale is calibrated in this manner, any frequency can be adjusted for with a deviation of less than ± 100 Hz (or ± 1 kHz in position "x 10"). An additional means of the calibration is provided for multiples of 500 Hz (or 5 kHz). Frequency coincidence is indicated by a pronounced dip of the J 2301 meter needle. Since the reading in the locked mode refers to the in-phase condition of two voltages, the meter needle will normally be unsteady.

5.2.4. External Control

The control signal for the generator PS-5 is applied to socket Bu 101 via the left-hand loop connector (across "control output I" and "control input PS-5"). The control signal for the receiver PM-5 is applied to socket Bu 104 via the right-hand loop connector (across "control output II" and "control input PM-5"). The control signal for PS-5 and PM-5 can be disconnected by unscrewing and removing the relative connector thus rendering the respective set inoperative.

This facilitates checking whether, for instance, the voltage measured on the PM-5 is the output voltage of the PS-5.

Under normal PSM-5 operating conditions it will be sufficient to sync. operate one PS-5 and one PM-5. However, there may be cases where two generators or two receivers require sync. control or where a separate receiver PMO-5 or a separate generator PSO-5 are externally controlled. The following connections are then necessary.

5.2.4.1 External Control of a Receiver by a Generator or of a Generator by a Receiver.

When a receiver is controlled by a generator, disconnect the right-hand bridge connector.

When a generator is controlled by a receiver, disconnect the left-hand bridge connector.

If external control is desired remove both connectors.

Provide the external-control connections from socket "control output I" or "control output II" in the controlling set to the corresponding socket "control input" in the controlled set using a cable with a characteristic impedance of $Z_o = 75\ \Omega$. The standard-frequency connection is accordingly provided between the jack "standard frequency output" of the controlling set and the jack "standard frequency input" of the controlled set using a cable with $Z_o = 75\ \Omega$.

To check for proper connection, connect the output of the PS-5 to the input of the PM-5.

Calibrate the PM-5 as described in 5.4.1. In the"low-noise" or "low distortion" mode, the level indicated by the PM-5 should than be equal to the output level of the PS-5. Make sure the generator output impedance and the receiver input impedance are switched to the same value.

5.2.4.2 External Control of a Second Generator or a Second Receiver

If a second generator is to be controlled, remove the right-hand bridge connector. If a second receiver is to be controlled, remove the left-hand bridge connector. Remove both bridge connectors of the set to be controlled.

Using a cable with the characteristic impedance of 75 Ω, provide the external control connection from the socket "control output I" or "II" in the controlling set to the corresponding socket "control input" in the controlled set (this is "control input PS-5" when a generator is controlled and the socket "control input PM-5" when a receiver is controlled

Using a cable with the characteristic impedance $Z_o = 75\ \Omega$, provide the standard frequency output" of the controlling set to the socket"standard frequency input" of the controlled set. To check for proper connections, make sure both generators supply a voltage when they are externally controlled. Where external control of two receivers is desired, make sure both indicate the same levels when the same input levels and frequencies are applied after calibration.

5.2.5 Sweep-Frequency Operation

The Level Measuring Set PSM-5 can be complemented with the Display Unit SG-1/SGE-10 and the Relay Unit RU-3 to constitute the Sweep Measuring Set WM-50 (see operating manual WM-50). All voltage sources for the sweep operation are provided in the Oscillator Unit RWO-5.

5.2.6 Standard Frequency

All frequencies required by PSM-5 for frequency generation and conversion are derived from the RWO-5 standard frequency of 1 MHz. Apart from the adjusting accuracy, the frequency accuracy of the measuring set thus depends only on the accuracy of this standard frequency.

5.2.6.1 Operation with External Standard Frequency

To enhance the frequency accuracy, the PSM-5 standard frequency generator can be substituted by an external 1 MHz standard frequency source of higher accuracy. Apply the external frequency to the input "standard frequency" The input impedance of this socket is approx. 1 kΩ. An r.m.s signal voltage of approx. 1 V is required. Apart from the necessary RF output impedance, the standard source output must include a d.c. resistance of max. 100 kΩ which is required to effect automatic switching-off of the internal standard when the external standard is applied.

5.2.6.2 Internal Standard Frequency Output

The internal standard frequency is available at the output "standard frequency" so that it can be checked or used as a standard for other circuits (frequency markers etc). The output impedance is 75 Ω and the peak-to-peak voltage at this frequency is about 1 V. Loading of this output will not affect the standard frequency.

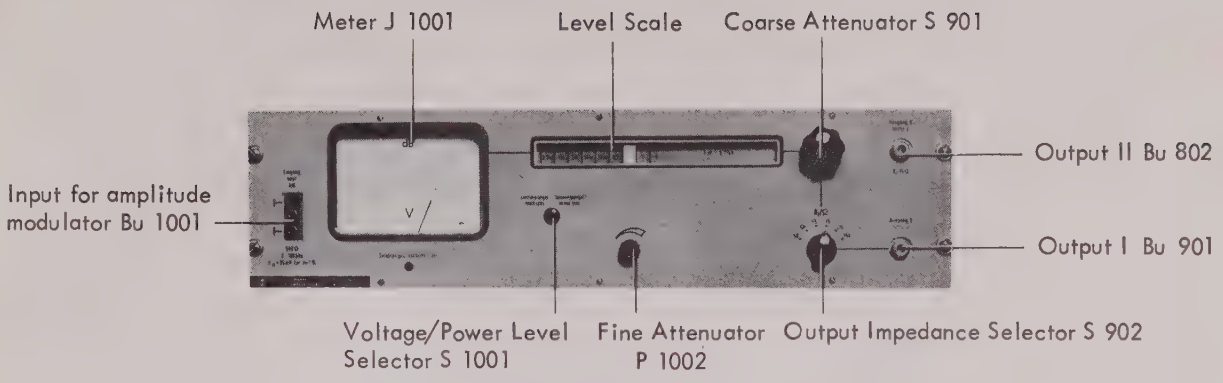

Meter J 1001
Level Scale
Coarse Attenuator S 901
Output II Bu 802
Input for amplitude modulator Bu 1001
Output I Bu 901
Voltage/Power Level Selector S 1001
Fine Attenuator P 1002
Output Impedance Selector S 902

Fig. 9 PS-5

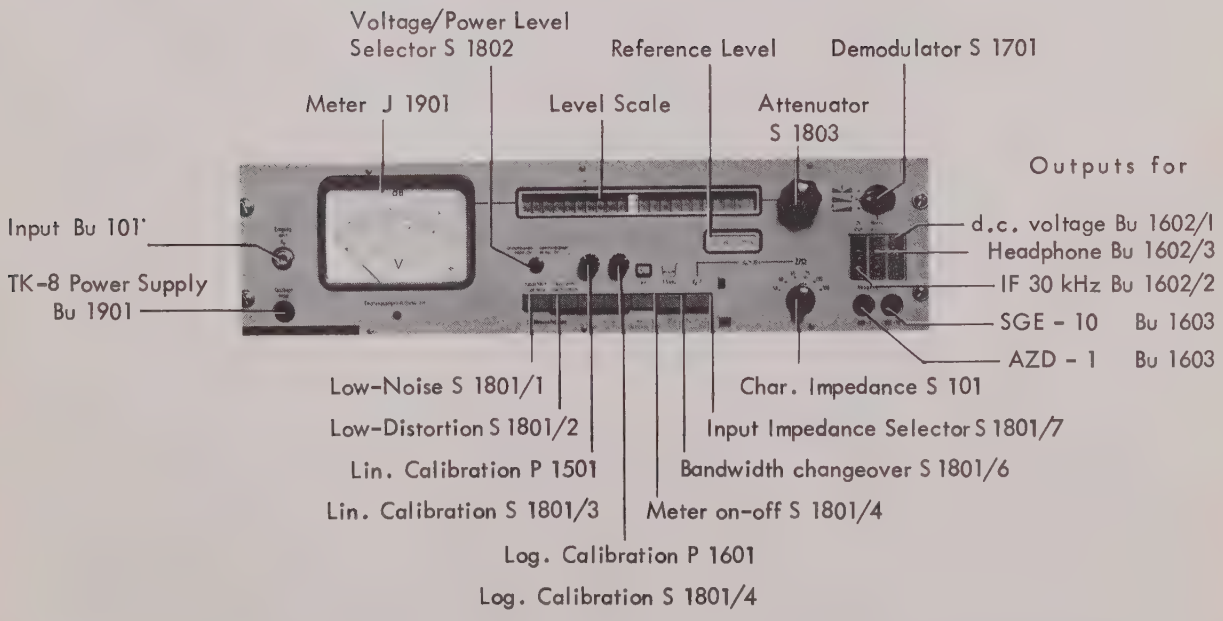


Fig. 10 PM-5

5.3 Signal Generator PS-5 (see Fig. 9)

5.3.1 Adjusting the Output Level

The output level of the signal generator is the sum of the levels indicated by the level scale and the scale of the signal generator level meter J 1001 whereby the reference level on the level scale must be taken into account. Operate the coarse attenuator S 901 to adjust the output level coarsely in 10 dB steps (or 1 Np steps, respectively). Fine adjustment of the output level is effected with attenuator P 1002. The level adjusted is maintained constant by an a.g.c. circuit.

Example for dB version (for output impedance = load impedance)
Level scale shows -20 dB, meter reads -3 dB: Generator output level is -23 dB.

Example for Np version (for output impedance = load impedance)
Level scale shows -2 Np, meter reads -0.3 Np: Generator output level is -2.3 Np.
Adjust the generator frequency on the RWO-5 (see 5.2.1). The generator output level is available at output I.

5.3.2 Output Impedance

The value indicated by the level scale and the meter scale is available at output I only when the load impedance R_L is equal to the impedance value adjusted with the output impedance selector S 902. This switch permits adjustment to the most frequently used load impedances between 50 and 150 Ω.

(Mismatch VSWR) : In the no-load condition, the output I generator level is 6 dB (0.7 Np) higher than the indicated value. For other VSWR, the generator output level has to be converted in the following ratio : output impedance to load impedance. In this conversion, the no-load level is to be used as the source voltage. The generator frequency is also available from output II. The generator level appearing at this socket can be adjusted with the fine attenuator P 1002 only. It is independent of the position of the coarse attenuator S 901 and is directly indicated by the meter J 1001. This level is thus available at the above mentioned socket only when output impedance and load impedance are equal to 75 Ω. The mismatch conditions are the same as for output I. The output level accuracy has been treated under 1.1.2.1.

5.3.3 Switching to Power Level Indication (dBm or Npm)

When the protective cap is removed selector S 1001 can be operated with a screwdriver. The reference level indication is thus changed. The inscription of the level scale is shifted by 10 dB (1 Np). Power level adjustments are achieved as decribed under 5.3.1 and 5.3.2 except for the paragraph on mismatch because. in measurements with power levels, only operation at matching condition ($R_{out} = R_L$) is practical. When the load impedance R_L is changed and, output impedance R_{out} selected accordingly the set automatically adjusts the generator output level across the outputs I and II so that it complies with the values indicated on the scales. This prevents reading and computation errors.

5.3.4 Connecting the Object under Test

Connect the object to the generator output I via a cable. The characteristic impedance Z_o of the cable must be matched to the output impedance of the generator and possibly also the input impedance of R_L of the object. The most favorable case is matching condition at both cable ends so that $R_L = R_{out} = Z_o$. Residual VSWR than have the least effect. If matching is impossible in special cases, select a connecting cable of minimum length. If measurements at elevated frequencies are desired, check directly at the load with the level meter PM-5 to ascertain whether there is any voltage transformation on the cable.

A second test object or instrument can be connected to output II which can be loaded independently of output I.

5.3.5 Distortion and Noise Voltages

The output signal of the generator may include,harmonic and non-harmonic interference voltages caused by unavoidable non-linearities of the generator mixer and generator amplifier.

Mixer distortion and noise are attenuated by about 50 dB. The generator level supplied to the outputs may nevertheless be distorted by the non-linearity of the final amplifier. At 36 MHz, the harmonics attenuation may be reduced to 30 dB (see 1.1.2.1).

The distortion attenuation of the final amplifier depends on the output frequency and level, i.e. it increases towards lower frequencies and lower drive voltages. The am-

plifier drive is reduced by turning the generator fine attenuator P 1002 anticlockwise. The position of the coarse attenuator does not effect the drive of the amplifier. The distortion properties of the generator can thus be improved by avoiding overdrive of the generator amplifier.

5.3.6. Amplitude Modulation (AM)

The generator output level can be amplitude-modulated with frequencies between d.c. and 100 kHz by an external generator via "Input AM" (socket Bu 1001). For each percent of the depth of modulation, approx. 35 mV are required. When the modulation voltage is constant, the depth of modulation will be constant over the whole output frequency range of the PS-5. The frequency response of the AM for constant modulating voltages is flat to approx. ±0.1 dB in the modulating-frequency range from d.c. to 100 kHz.

The mean generator output voltage remains constant during modulation and is indicated by the meter J 1001.

The peak amplitude of the modulated generator level must not exceed the maximum generator level, otherwise additional distortion will occur. Therefore, when the depth of modulation is high, adjust the generator output level to about -5 dB (-0.5 Np) as indicated by the meter J 1001. The total distortion coefficient K_{tot} for m = 30 % is then max. 3 %.

The amplitude control of the PS-5 is automatically switched off when a plug is inserted into "Input AM". The frequency response of the generator output may then be about ± 1 dB (± 0.1 Np).

The socket "Input AM" is d.c. coupled. Therefore, the generator output level can be keyed via this input.

5.4. Receiver (see Fig. 10)

5.4.1. Calibration

Linear and logarithmic calibration of the receiver is effected in separate operations, whereby the test signal of the input need not be disconnected.

5.4.1.1. Linear Calibration

Prior to undertaking level or end-to-end measurements, both the key S 1801/3 (see Fig. 10) indicated by a red triangle and the meter ON/OFF button S 1801/5 designated "ein" must be depressed. The frequency locking switch S 401 of the RWO-5 (see Fig. 8) must be positioned to "locked" and the coarse tuning oscillator of the RWO-5 adjusted to 100 kHz with control D 1 on the front panel of RWO-5. The sweep width selector must be positioned to "0 to 100 kHz" or "0 to 1 MHz" (see RWO-5 front panel, Fig. 8). By tuning the interpolation oscillator to approx. zero with the aid of control D 2 (see RWO-5 front panel, Fig. 8) the receiver meter J 1901 (see Fig. 10) must indicate max. deflection. The pointer is then returned to coincide with 0 dB (0 Np) using the lin. calibration knob P 1501 (see Fig. 10) indicated by a red triangle.
When undertaking attenuation or loop measurements, it is of advantage to calibrate the receiver against the generator output level and not the calibration level. The generator output level having the test frequency is applied directly to the receiver PM-5 in the mode "low distortion" via a suitable cable. The terminating resistors and the cable must posses an identical characteristic impedance. The receive level as indicated by the meter J 1901 of PM-5 is adjusted to correspond with PS-5 output level by means of the lin. calibration knob P 1501. When the test object is inserted, the level difference is obtained directly without the errors introduced by the generator output level, the calibration oscillator voltage and the frequency response. For relative measurements the position of P 1501 may, of course, be optional.

5.4.1.2. Logarithmic Calibration

In this mode, the button S 1801/4 (see Fig. 10) indicated by a blue triangle must be depressed and the meter indication of J 1901 set to -20 dB (-2 Np) by means of the log. calibration knob P 1601 (see Fig. 10).
The warranted scale division error is valid under correct calibration condition only.

5.4.1.3. Alignment of the Carrier Balance

An unbalance of mixer I could cause the residual carrier to over-drive the following amplifier stage, thus causing an incorrect indication of the signal. Poor balance will greatly increase the inherent noise of the receiver at low frequencies.
Balance alignment: Switch the PM-5 to "CAL. log" and adjust RWO-5 to frequency

zero (max. reading on PM-5). Adjust the potentiometer P 2001, accessable on the rear panel, with a screw driver for a minimum meter reading at the PM-5.

.2. Measuring

The receiver sensitivity is adjusted by means of the coarse attenuator S 1803. The signal-voltage level is obtained as the sum of the two values indicated by the level scale and by the meter J 1901, whereby the reference level below the level scale must be taken into account.

Example for dB version:

Level scale reads -80 dB, meter reading -6 dB; receive level is -86 dB.

Example for Np version:

Level scale reads -8 Np, meter reads -0.6 Np; receive level is -8.6 Np.

The receive frequency is adjusted on the RWO-5.

The receive level accuracy is given in section 1.1.3.1. of the specifications.

Selecting the measuring mode:

Depress either S 1801/1 (low noise) or S 1801/2 (low distortion) as desired.

4.2.1. Low-Distortion Mode

This mode is used for distortion measurements and frequency spectrum analysis (see also 3.4.5.1). Avoid selecting a measuring range of excessive sensivity especially for distortion measurements. The sensivity of the PM-5 can be made 50 dB (6 Np) higher than the sum level of the signal voltage. In this case, the intrinsic distortion of the PM-5 is attenuated by 70 dB (8 Np) or more over the whole frequency range. A further increase of receiver sensitivity may introduce measuring errors or apparent distortion and noise voltages due to overloading.

5.4.2.2. Low-Noise Mode

This mode finds particular application in sweep measurements and when very small level differences are to be investigated (see also 3.4.5.2). Other measurements may also be undertaken in this mode when only the receive frequency is applied to the receiver in the absence of other signal frequencies having a level much higher than that of the test signal. When this is doubtful alter the receiver sensitivity with the attenuator and observe whether the meter reading is changed by the same amount. This meth-

od is also applicable in the low-distortion mode when a distortion attenuation exceeding 70 dB (8 Np) is to be measured; it constitutes a reliable check for most applications.

5.4.2.3. Switching to Power-Level Measuring

When the protective cap is removed, the selector S 1802 can be operated with a screwdriver, whereby the reference-level reading will change and the inscription of the level scale is shifted by 10 dB (1 Np). For power-level measurements refer to section 5.4.2.

In addition, observe the following:

Power levels are measured in the PM-5 as voltage levels referred to a certain impedance. The level measured is therefore in all cases the power level referred to the input impedance that is adjusted by the impedance selector S 101. The receiver can measure power levels for all six characteristic impedances adjustable with S 101. The sensitivity of the receiver is automatically changed when this selector is operated, so that the same scale can be used in all cases. This avoids reading and conversion errors. The receiver also permits power level measurements of an object that is already terminated with its characteristic impedance. In this case, release the input impedance button to position $R_e = \infty$, $C_e \approx 30$ pF. Adjust the impedance selector to the characteristic impedance to which the power level is to be referred.

5.4.3. Input Impedance R_e

5.4.3.1. High impedance mode

In a measurement where the voltage or the object should not be loaded, the input of the PM-5 can be switched to high impedance by releasing the input impedance button S 1801/7 to position "$R_e = \infty$, $C_e \approx 30$ pF". The voltage source is then loaded solely by the input capacitance of the receiver and the connecting cable.

Caution:

In the range 1 to 5 MHz, the loss factor of the input impedance can assume negative values. The resulting parallel resistance is about 100 kΩ. Therefore, the resistive component of the voltage source's internal impedance must not exceed 100 kΩ in this range.

At high signal frequencies, the connecting cable may be terminated by a mismatch

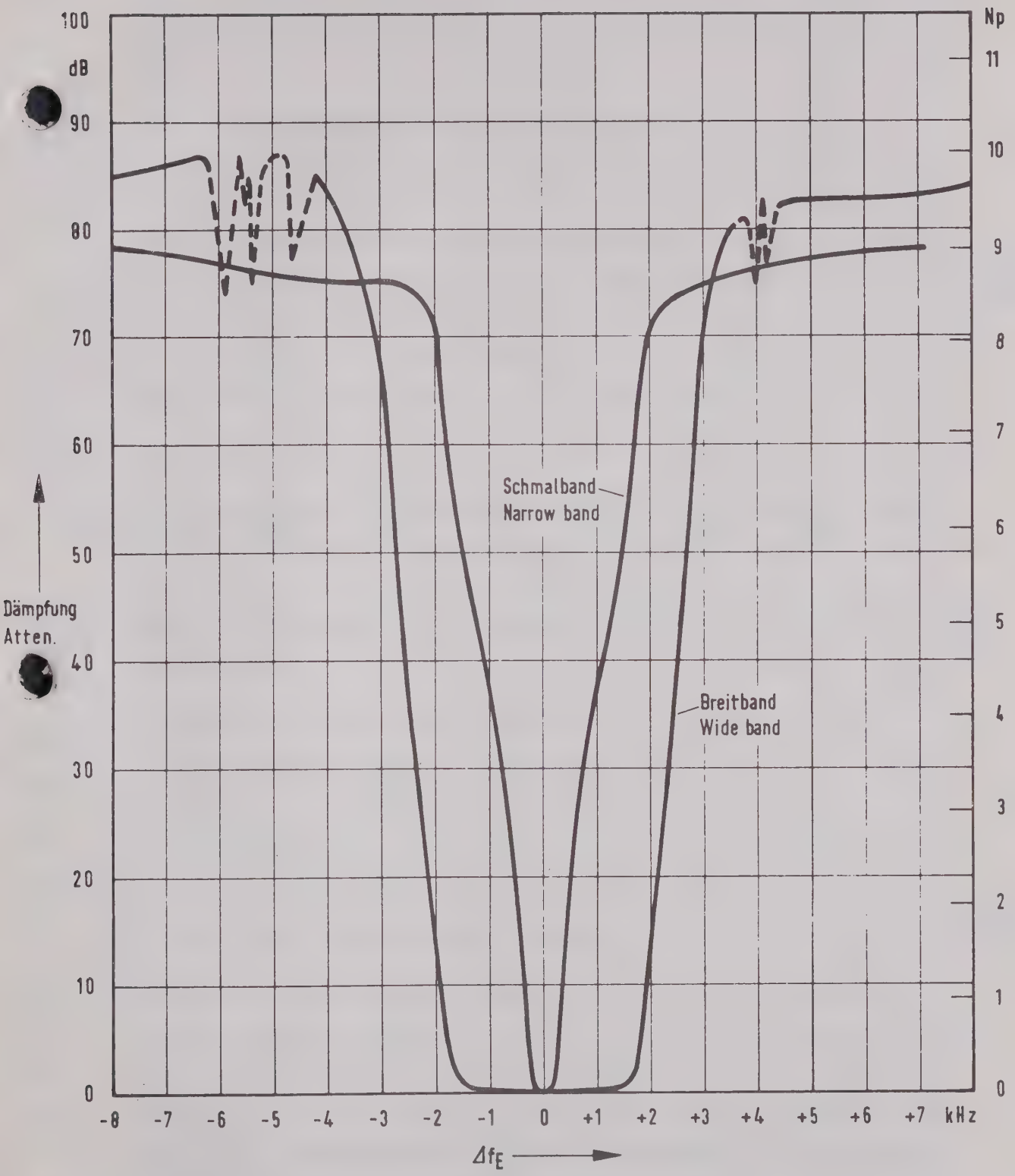
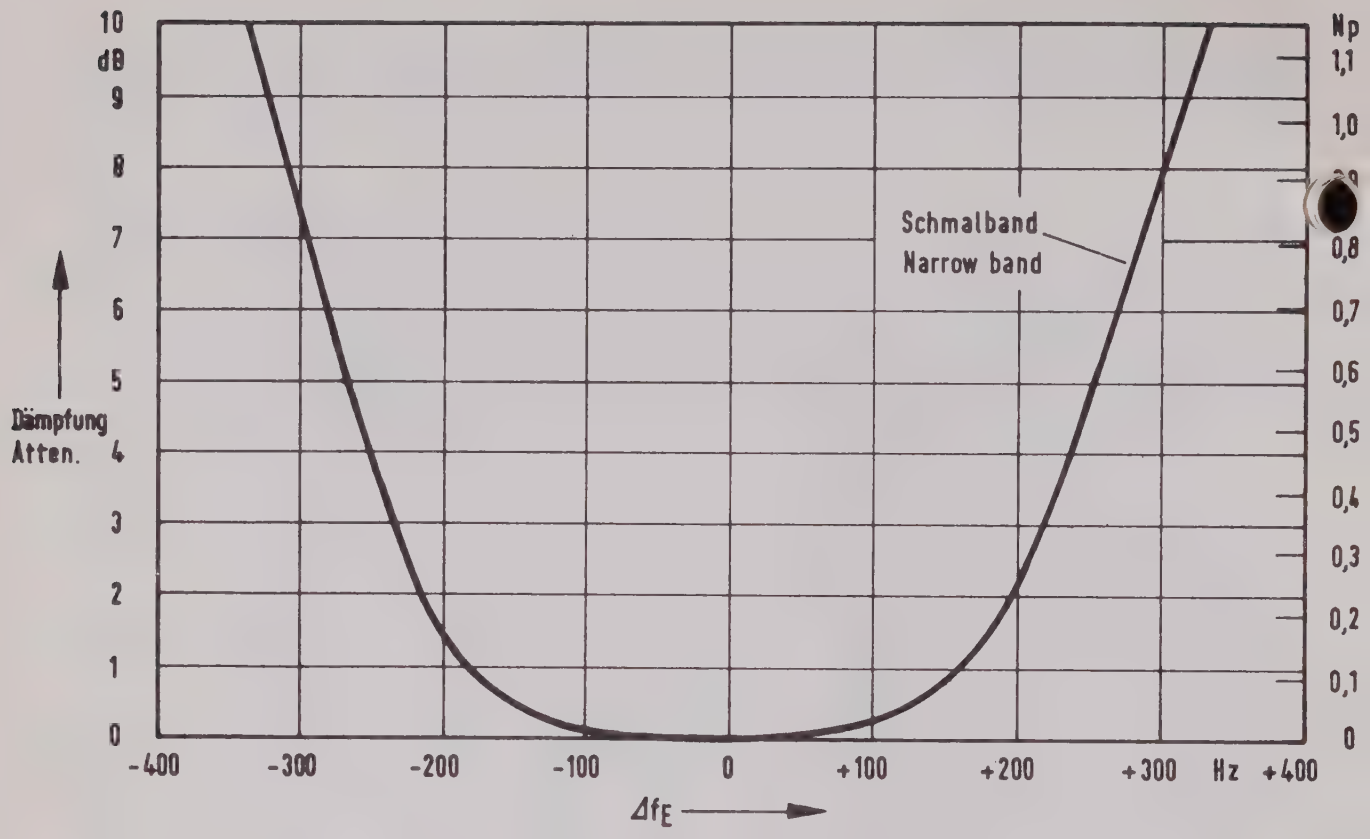


Bild 11 Selektionskurve des PM-5
Fig. 11 Selectivity characteristic of the PM-5

f_E = Empfangsfrequenz (Receive frequency)



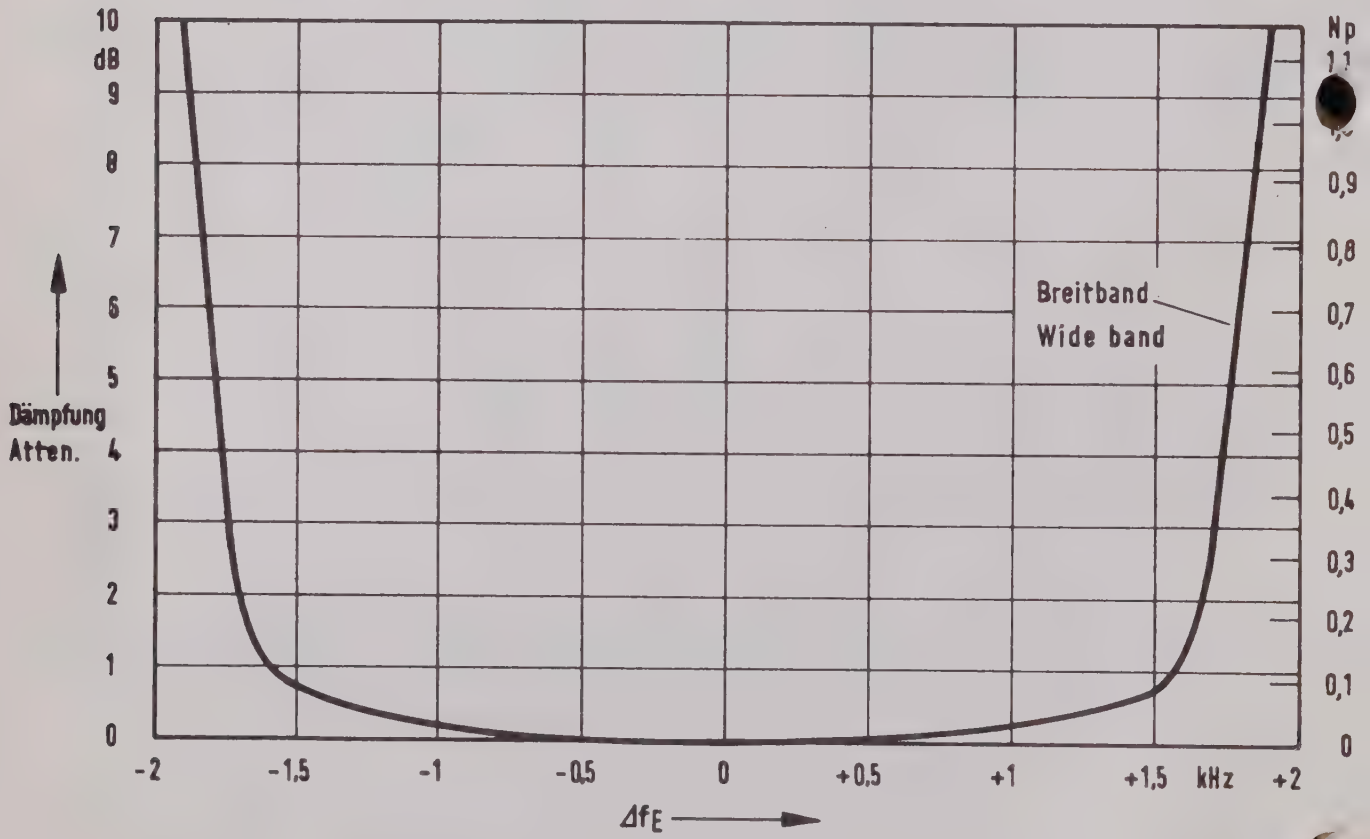


Bild 11a Selektionskurve des PM-5
Fig. 11a Selectivity characteristic of the PM-5

which would result in a voltage transformation and measuring errors. If it is impossible to provide for a matched condition use of the Probe TK-8 is recommended (see Section 5.6.).

5.4.3.2. Input Impedance R_e equal to Characteristic Impedance Z

In the position $R_e = Z$, the impedance chosen by the input impedance selector is connected to the input of the receiver, the pushbutton S 1801/7 (designated R_e) being depressed. The PM-5 can thus be matched to all customary characteristic impedances of cables and systems. In a matched condition voltage transformation on the cable is avoided. The cable length has thus no effect upon the measurement.
The accuracy of the various input impedances expressed in terms of the corresponding reflection factors is given under 1.1.3.2.of the specifications.

5.4.4. Bandwidth and Selectivity

The receiver bandwidth can be selected with button S 1801/6 (see fig. 10). The 3 dB bandwidth of the selectivity characteristic (see fig. 11 and 11 a) is stated. The selectivity is independent of the selected receive frequency. The "large" bandwidth of approx. 3.5 kHz corresponds to the bandwidth of a speech channel. It is used for the following tasks:

a) Location of unknown receive frequencies,
b) Measurement of voltages with high signal-noise ratio
c) Operation with the demodulator unit in the demodulation of speech etc.

The "narrow" bandwidth of approx. 500 Hz is best used for the following tasks:

a) Analysis of adjacent frequencies
b) Measurement of signals with high noise levels

Recalibration of the receiver is not necessary when switching from the large to the small bandwidth. The tuning condition must, however, be checked because of the very flat characteristic in the midband region of a wideband measurement, a detuning of several hundred Hz results in only a very small change of the meter needle deflection. In the narrow bandwidth mode a detuning of approx. 50 Hz gives a good reading. All frequencies outside of the detuning frequency by more than 10 kHz, are attenuated by at least 70 dB (8 Np). For frequencies closer to the tuning frequency, the attenuation may be taken from the figures 11 and 11 a.

5.4.5. Disconnecting the Meter

The meter J 1901 can be disconnected by releasing the meter ON/OFF button S 1801/5 (see fig. 10) thus selecting the position "measuring trace". This facility should be used especially in sweep measurements to prevent unnecessary meter loading.

When the receiver is operated in the sweep mode and the Display Plug-In Unit SGE-10 is connected to the receiver, the reference line of the SGE-10 can be indicated by the meter J 1901. For this purpose, set the selector "reference line" of the SGE-10 to position ON and releasing the meter ON/OFF button S 1801/5 on the PM-5 to position " measuring trace " to inject the reference line. The meter and the reference line can thus be utilized for calibration of the CRT screen display as well as for measuring the sweep-frequency characteristic on the same screen.

5.4.6. Demodulator Unit

An AM receive signal can be demodulated with this unit. The demodulated signal is available at the "headset" socket.

The output has an output impedance of approx. 10 kΩ. The output voltage for only one modulating frequency in the no-load condition is, referred to the full-scale deflection on the meter J 1901:

approx. 0.5 V for single-sideband modulation, normal or inverted position

approx. 0.15 V for double-sideband modulation with a depth of m = 30 %

The type of modulation can be adjusted with the demodulation switch S 1701.

The conversion frequencies for the single-sideband demodulation are coupled with the bandwidth adjusted:

In the position 3.5 kHz of the bandwidth switch, the receive frequency adjusted on the RWO-5 is converted to 2 kHz. For proper demodulation of a single-sideband modulation, the frequency on the RWO-5 should be adjusted 2 kHz away from the suppressed carrier, that is:

RWO-5 detuned by + 2 kHz in normal position

RWO-5 detuned by − 2 kHz in inverted position

Thus the demodulated frequency band is converted into the range of about 250 Hz to 3.75 kHz.

In the position 500 Hz of the bandwidth switch, the receive frequency adjusted on the RWO-5 is converted to 1 kHz. This adjustment is particularly useful when one or several closely spaced frequencies are to be converted into the most favorable audio range. For proper demodulation, the frequency on the RWO-5 should be adjusted 1 kHz away from the suppressed carrier, that is:

RWO-5 detuned by + 1 kHz in normal position
RWO-5 detuned by − 1 kHz in inverted position

The demodulated frequency band is thus converted into the range of about 750 Hz to 1.25 kHz.

For demodulation of a double-sideband modulated oscillation, adjust the RWO-5 receive frequency to the carrier of this oscillation. Switching of the demodulator unit has no effect upon the measuring accuracy of the receiver.

The output sockets a and b of the output terminal are floating. Ground is connected to socket c.

5.4.7. Outputs

The outputs supply the signal measured in various forms for further use. Loading of these outputs has no effect upon the measuring accuracy of the receiver providing that the latter is re-calibrated.

5.4.7.1. Output IF 30 kHz

This output provides the last IF of the receiver, 30 kHz. The output impedance is 600 Ω. The no-load output level corresponds to that indicated by the meter J 1901. This output can be used for connection of recorders with an a.c. voltage input, highly selective analysers (for instance, KLA-48), frequency counters and similar devices. The sockets a and b of the output terminal are floating. Socket c is grounded.

5.4.7.2. Audio Output

See demodulator unit, section 5.4.6.

5.4.7.3. D.c. Voltage Output $U_{=}$

This output provides a d.c. voltage. The internal impedance is 10 kΩ. The no-load output voltage for full-scale deflection on the meter J 1901 is 6 V. This output is suitable for the connection of recorders, display units, oscilloscopes, and similar devices. Sockets a and b of the output terminal are floating. The plus pole is con-

nected to socket a, ground is connected to socket c. The output can be loaded to $Z_{out} = 0$.

5.4.7.4. Output AZD-1

Here the Scale Expander AZD-1 can be connected via a 5-pole cable. The set ser to measure very small level differences. See section 5.5.

5.4.7.5. Output SGE-10

Here the Y input of the Display Plug-In Unit SGE-10 can be connected via a 5-pole cable. The SGE-10 is required when the PSM-5 is to be used in the Sweep Measuring Set WM-50 (see Manual WM-50).

5.5. Scale Expander AZD-1 (see Fig. 12)

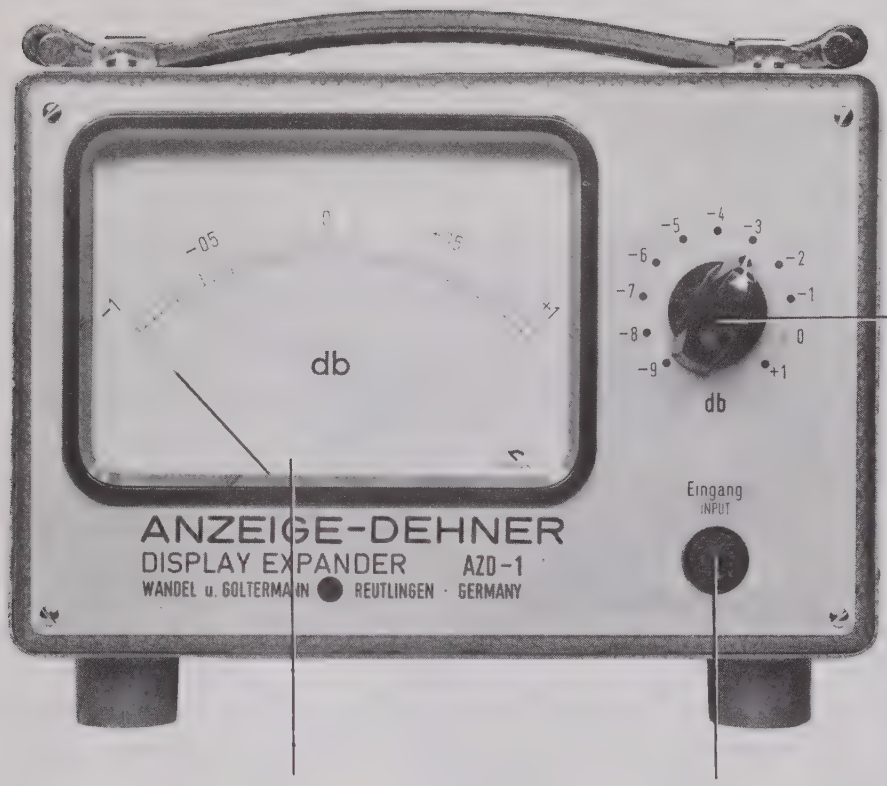
This device is provided for measurements of very small level differences in the mode "linear" of the PM-5. It is connected via a 5-pole cable to the socket connector "AZD-1" of the PM-5. When the cable plug is inserted, the set is ready for operation since the operating voltage is obtained from the PM-5 via the same cable as the signal voltage.

5.5.1. Calibration

For calibration, the PM-5 must be operated in the linear calibration mode (button S 1801/3 depressed) or a signal level of 0 dB (0 Np) should appear on the meter of PM-5 in the low-noise mode. The attenuation selector of the AZD-1 must be positioned to 0 dB (0 Np). Using a screwdriver, adjust the calibration potentiometer P 1 on the front panel of the AZD-1 so that the meter needle of the J 1 points to the scale marker 0. The instrument indicates difference values. The scale range is ± 1 dB (± 0.1 Np).

5.5.2. Measuring

When using the AZD-1 for measuring purposes the PM-5 is operated in the low-noise mode. Bring the reference level up to the signal level indicated by the PM-5 meter to a difference of less than 1 dB (0.1 Np) by means of the AZD-1 attenuation selector S 1. The level indicated by the AZD-1 meter then represents the deviation from the corresponding level value, selected with the attenuation selector. Obtain the level readings as follows:



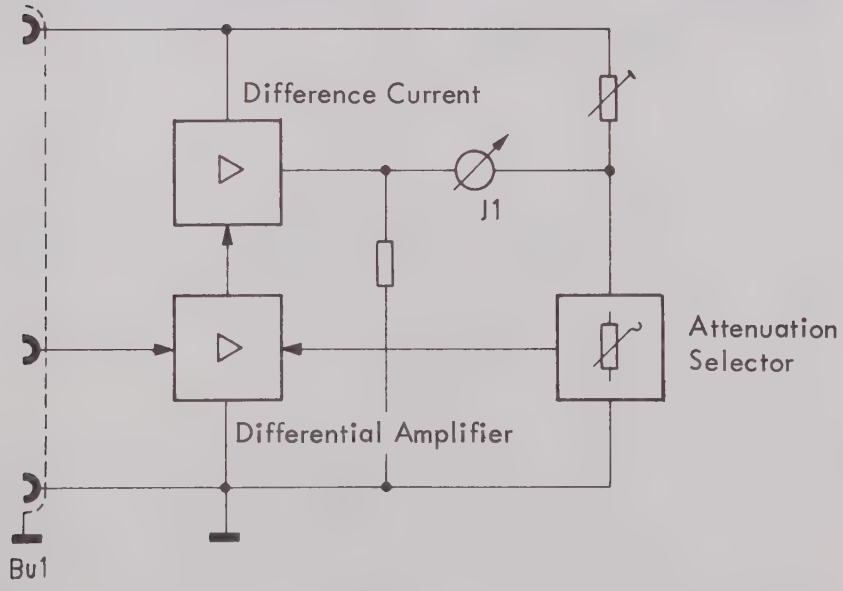


Fig. 12 Scale Expander AZD-1
(available with dB or Np calibration)

	Example for dB instrument	Example for Np instrument
Reading on PM-5 level scale S 1803	-40 dB	-4 Np
+ AZD-1 attenuator position	- 6 dB	-0.6 Np
+ AZD-1 meter reading	- 0.33 dB	-0.033 Np
resulting signal level	-46.33 dB	-4.633 Np

For relative measurements, only the AZD-1 meter reading is required.

The range of the AZD-1 attenuation selector overlaps each 10 dB (1 Np) step of the PM-5 attenuator. The AZD-1 can thus be used for measurements down to the level range -80 dB (-9 Np). Below this level range, the meter needle of the AZD-1 becomes too unsteady due to the increased noise level.

5.5.3. Reading of the Reference Line of the Display Plug-In Unit SGE-10

When the PM-5 is operated in conjunction with the SGE-10, the level corresponding to the reference line is measured with the AZD-1. To do this release the meter ON/OFF button S 1801/5 on the PM-5 to position "reference line" ("measuring trace"). The reference-line voltage is then indicated by the PM-5 meter and after adjusting the attenuation selector, also on the AZD-1 meter. This affords the exact measurement of even small attenuation differences of a sweep-frequency characteristic curve.

5.6. Probe TK-8 (see Fig. 13)

The probe TK-8 finds application for low-capacitance and high-impedance measurements on test objects. Since the probe derives the level directly from the individual test points all errors due to cables, mismatch, etc. are eliminated.

The probe connector St 1 is applied to the input socket of the PM-5. The knurled ring is then turned clockwise for a locked connection to the input socket. Set the input impedance button S 1801/7 of the PM-5 to position $R_e = \infty$, $C_e \approx 30$ pF (button released). Plug the connector St 2 of the TK-8 into the "probe" socket of the PM-5. The probe is then ready for operation.

The TK-8 has an attenuation of 2 dB (0.2 Np). This must be considered during level measurements. For prolonged measurements with the probe, it is recommended to balance its attenuation with the calibration knobs "lin" (P 1501) and "log" (P 1601) of the PM-5. This eliminates the need for a conversion of the readings.

The specifications for the TK-8 in section 1. include the errors originating from the PM-5.

Fig. 13 Probe TK-8 (The adapter screwed to the probe is used only for measurements requiring 4/13 mm coaxial connectors)

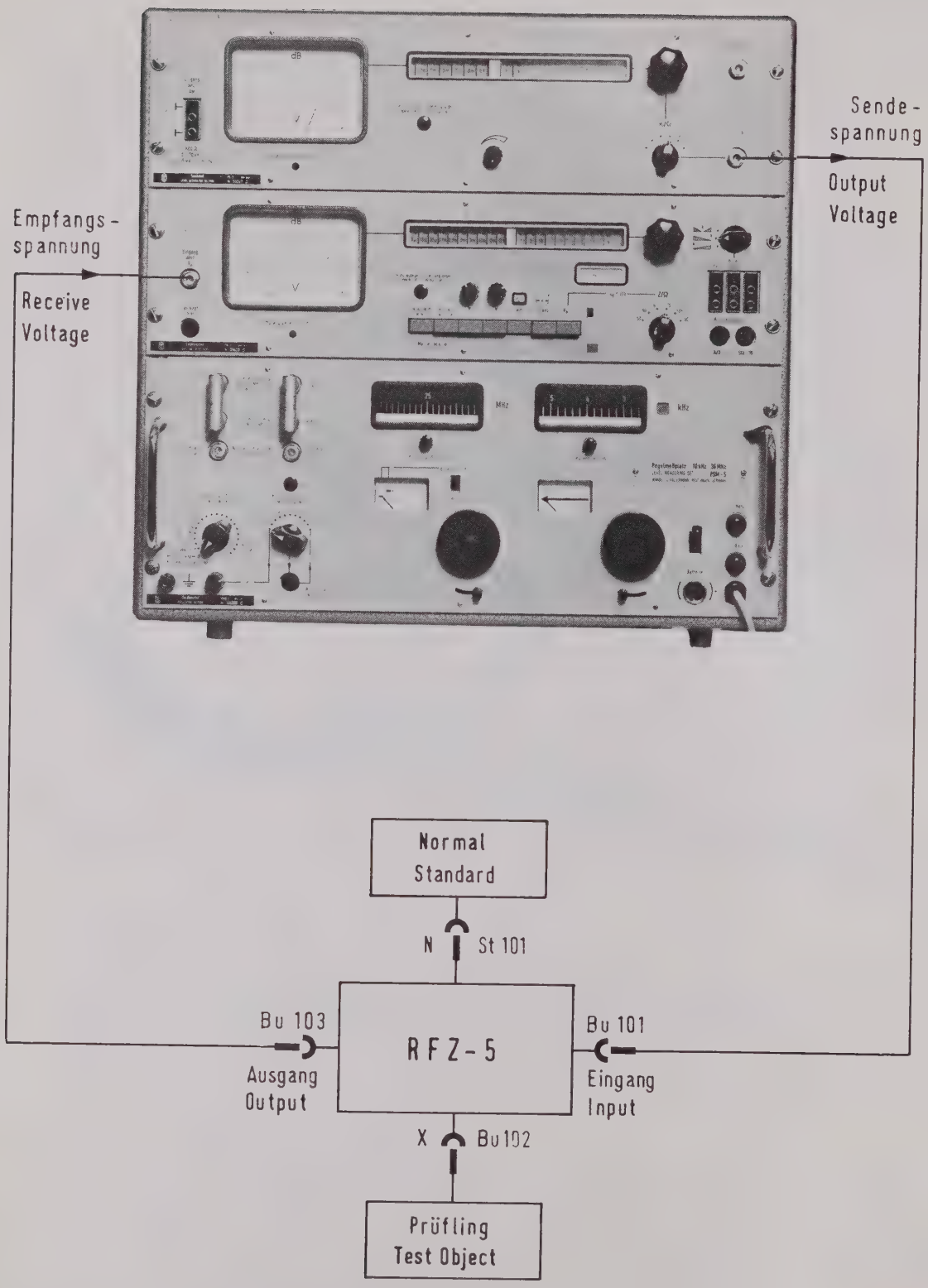


Bild 14 Zusammenschaltung des RFZ-5 mit dem PSM-5
Fig. 14 Connexion of RFZ-5 to PSM-5

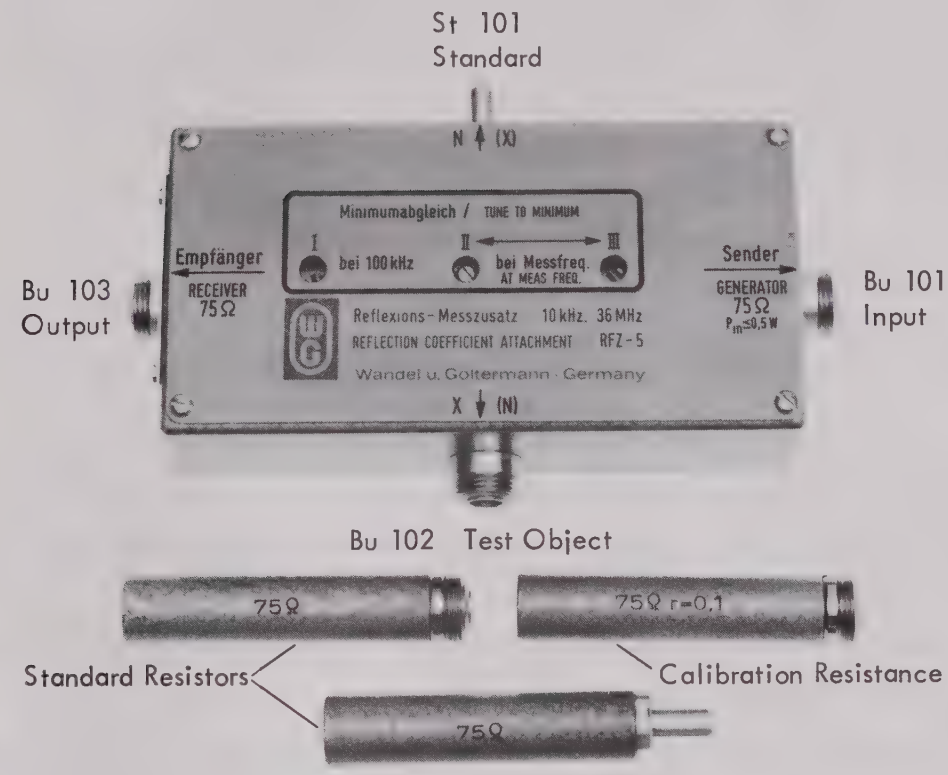


Fig. 15 Return Loss Accessory with Standard Resistors

This accessory permits measuring and sweeping of the reflection coefficient (return loss) of any object referred to a standard. The RFZ-5 is connected to the measuring set PSM-5 as shown in Fig. 14. The connecting cables to the PSM-5 are matched to 75 Ω so that the RFZ-5 can be connected via cables and used in the close vicinity of the object under test.

The accessory operates on the principle of the Wheatstone bridge. This bridge is resistive for low frequencies and can be additionally capacitance-balanced for high frequencies.

5.7.1. Calibration of Return Loss

For this purpose the standard resistor R_N is inserted into socket "X" and the calibration resistor R_E (having a standardized reflection factor of 0.1) plug onto "N". The le[illegible] indicated by the PM-5 then signifies a return loss of 20 dB (2.3 Np) i.e., a reflection factor of 10 %. When the output voltage of the PS-5 or the sensitivity of the PM-5 (see 5.4.2) is then varied, the needle of the meter J 1901 of the PM-5 shows a deflection of 0 dB (-0.3 Np).

5.7.2. Recalibration of RFZ-5

Alignment of the intrinsic return loss of the bridge is achieved with two standard resistances, one of which is inserted into socket "X", the other plug onto "N".

For measurements at a fixed frequency, potentiometer I is used for alignment to a minimum PM-5 meter needle deflection. Alignment is first carried out at 100 kHz with potentiometer I and then at the corresponding signal frequencies with alternate use of trimmer II and potentiometer III.

This procedure requires a certain amount of "feel". The alignment state, once attained, has a long-term stability.

In the sweep mode it is advisible to align by making use of the curve on the display unit screen. In this way various attenuation characteristics and poles can be attained (see fig. 16). Near-continuous characteristics are achieved by using the alignment elements I, II and III, whereby at lower frequencies, however the intrinsic return loss is reduced but is always better than 50 dB over the full frequency range.

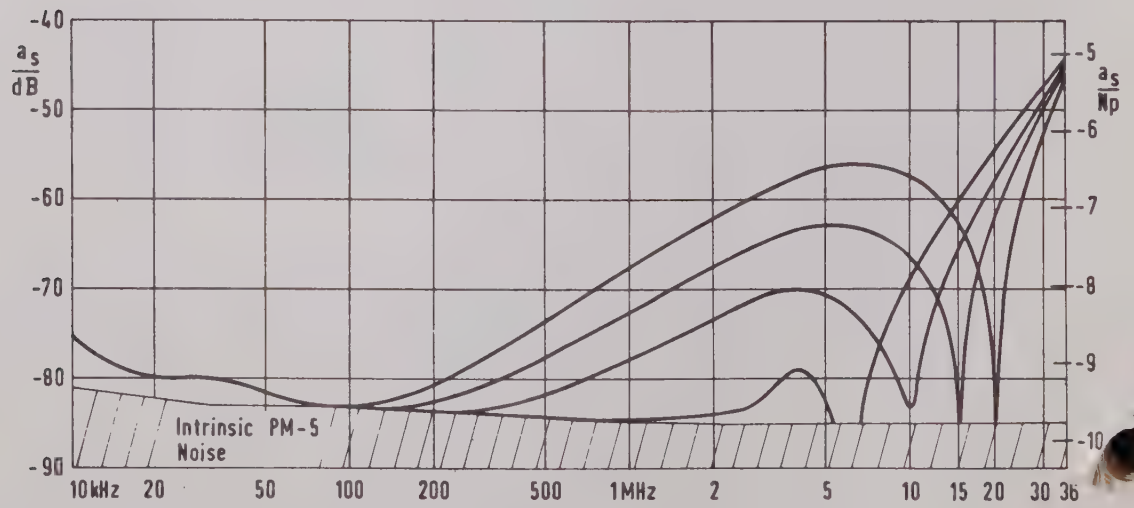


Fig. 16. RFZ intrinsic return loss at a standard resistance $R_N = 75\ \Omega$

The frequency response of the bridge is aligned with trimmer IV located on the rear side of the RFZ-5. After having inserted a standard and a calibration resistance into RFZ-5 the receive indication in the frequency range of interest is adjusted to a constant value, whereby the frequency response of the generator and receiver is also involved.

5.7.3. Measuring

The 20 dB return loss obtained from calibration with R_N and R_E ($r = 0,1$) was made equal to a PM-5 meter reading of 0 dB resp. -0.3 Np (see 5.7.1).
After this calibration, a return loss of 0 dB resp. 0 Np (when $R_x = 0$ or $R_x = \infty$) corresponds to a PM-5 meter reading 20 dB (2.3 Np) higher than the calibration reading. This value is then the return loss reference.

Example	dB instrument	Np instrument
Level reading on PM-5 during calibration of RFZ-5	-70 dB	-7.3 Np
Return loss reference (Return loss 0 dB or 0 Np)	-50 dB	-5 Np
Reading with test object connected	-76 dB	-8 Np
Return loss (measured value minus reference)	26 dB	3 Np
Reflection coefficient	5 %	5 %

For a return loss of 0 dB (0 Np), the RFZ-5 has an attenuation of 47 dB between input and output.
After variation of the PS-5 output level or the PM-5 calibration, the return loss calibration must be repeated.

Connecting the object under test:
Connect the object to socket "X". The return loss measured then refers to this socket. Test objects which are not easily accessible can also be connected via one of the 25 cm test leads. In this case, the other 25 cm test cable is to be connected between plug "N" and the standard resistance. The connections "N" and "X" are equivalent in function, thus enabling test object and standard resistance to be interchanged.

5.8 Additional Operating Instructions

5.8.1 Apparent 1 MHz Locking Frequency Indication

During tuning, the coarse oscillator signal is compared with the harmonic of a 1 MHz standard frequency f_o in the phase meter. The output signal of the phase comparison serves to effect frequency control of the coarse oscillator and indication of the locked frequency condition.

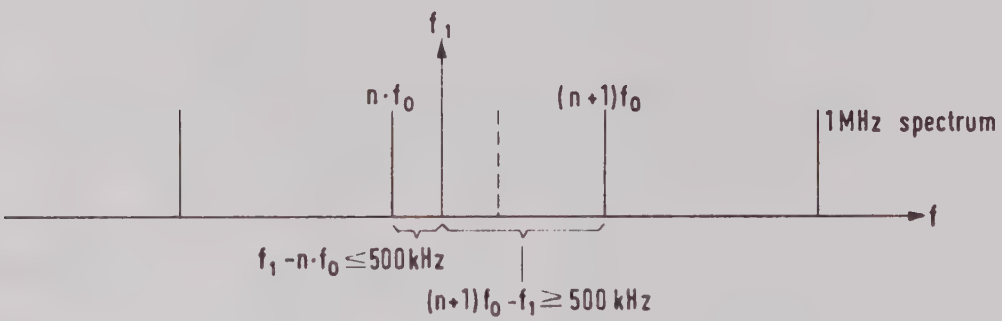


Fig. 17

The difference frequency $f_1 - n \cdot f_o$ of max. 500 kHz is used for indication. At zero difference frequency the meter reading of J 2302 returns to the 1 MHz marker. When the tuning frequency f_1 is positioned exactly between 2 lines of the 1 MHz spectrum, however, then $f_1 - n \cdot f_o = 500$ kHz. The coarse oscillator frequency is then locked to a multiple of 500 kHz. Both of the resulting difference frequencies have corresponding amplitudes and are phase shifted by 180° due to the stability of the locked coarse oscillator frequency. Thus both signals always cancel each other out, the difference frequency at the phasemeter output is zero and the meter reading of J 2302 returns to the 1 MHz marker.

An apparent 1 MHz has thus resulted.

This apparent locking frequency indication easily results especially in the upper frequency range of the coarse tuning oscillator. The operator should, however, have no difficulty in discriminating a true 1 MHz indication from an apparent one, once having been informed of its existence.

The calibration pointer is an aid in discriminating the true 1 MHz indication since only in the presence of a true 1 MHz indication will it coincide with a MHz scale mark.

5.8.2 Interference Voltage Location using PSM-5

Measuring Task: Small interference levels of approx. -80 to -100 dB are to measured on an exposed unscreened test object located in the near vicinity of the measuring instrument, whereby the PM-5 receiver and the TK-8 probe is made use of.
The probe is merely touched to the test point, an earthed connection between probe and test object being simultaneously present. A coaxial connection is thus absent.

During this measuring task the PS-5 generator under synchronuous no-load condition may couple its output frequency into the high impedance test object either directly or via an adjacent mains lead.
There is thus a danger of the receiver indicating an interference level introduced by the PS-5 instead of the desired test level. This can be avoided by removing the bridge connector across the sockets Bu 103 and Bu 102 on the left-hand side of the RWO-5 front panel, thus switching-off the generator output frequency.

5.8.3 Keying of Generator Output by means of a d.c. Voltage at Modulator Input Socket Bu 1001

Due to the d.c. coupling between the modulator input and the PS-5 a.g.c. circuit, it is possible to key the generator output by means of a positive or negative d.c. voltage.
The values in the following table are valid with the a.g.c. circuit rendered inoperative by insertion of a plug into the modulator socket Bu 1001 (front panel of PS-5).

d.c. voltage at Bu 1001	PS-5 meter reading	Attenuator Output Voltage	Attenuator Position
0 V	0 dB (0 Np)	1.55 V	0 dB (0 Np)
+3.5 V	needle fully right	3.9 V	0 dB (0 Np)
-3.5 V	needle fully left	$<$ 100 mV	0 dB (0 Np)

A limitation of the output voltage as indicated by the oscilloscope display is intruduced at a no-load voltage of approx. 4.4 V.

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